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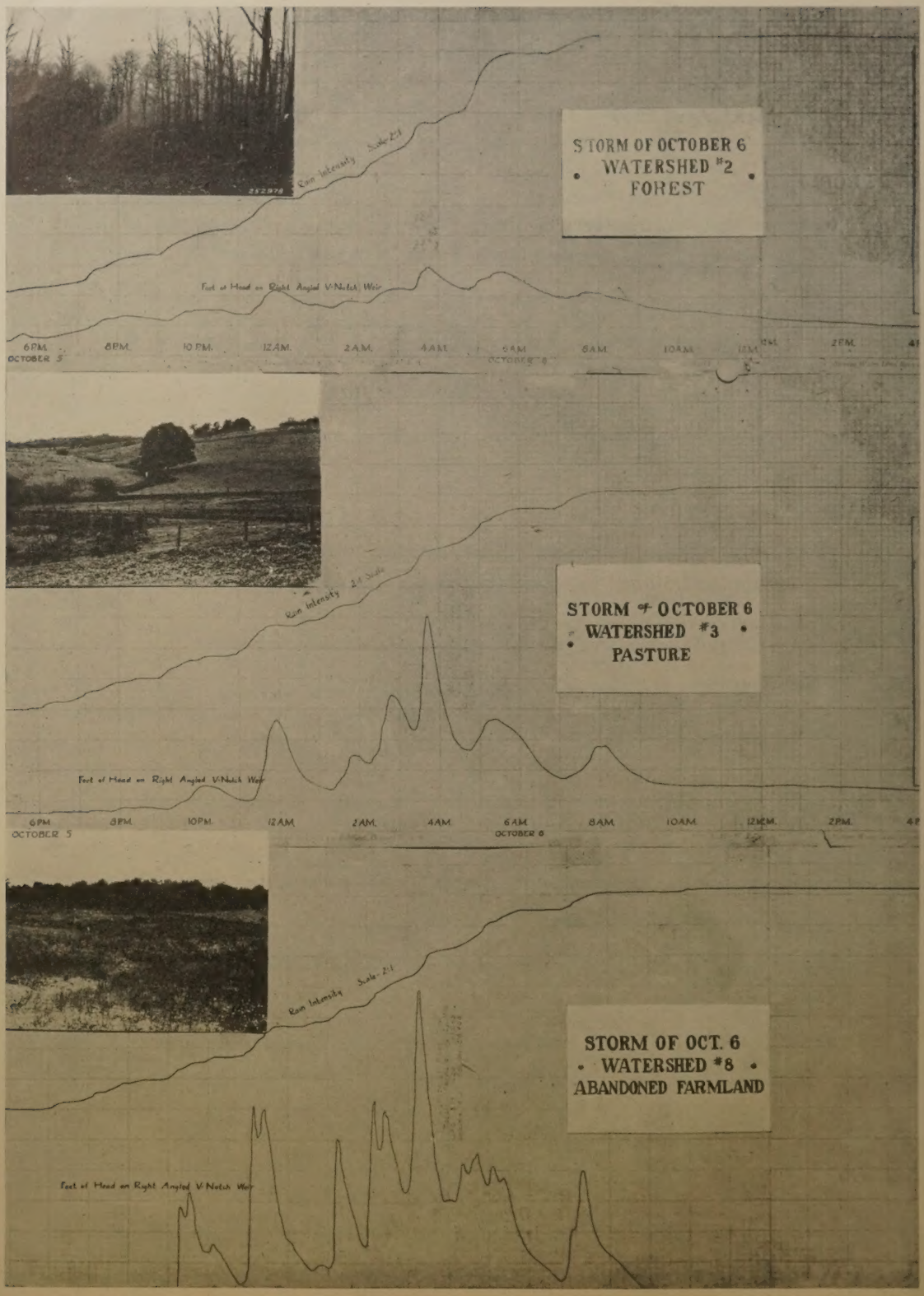

The condition of the watershed glen determines whether floods or gentle rises result from heavy rains.

Valuation of Forest Lands From the Public Viewpoint

By BERNARD FRANK

THE important role of wood in World War I belied the complacent opinion — in the United States of America at least — that the depletion of this resource was of little consequence. The even greater part played by wood in World War II and the effects of present timber shortages have driven home hard the lesson that without plentiful supplies of this strategic material the march toward world recovery and more peaceful international relations may be seriously, perhaps indefinitely, retarded.

When one speaks of wood one inevitably thinks of the forests that produce it. And when forests are discussed there inevitably come to mind the many other functions performed by the tree- and shrub-growing areas of the earth. It is precisely this characteristic which so firmly establishes the widespread social value of forest land.

Within the United States, as in many other parts of the world, the public interest in such land is well established. It extends to all elements of that national resource. The prime recreational qualities of the forest environment, its high wildlife habitat values, and its beneficial influences upon water flow, especially the last, are well recognized in the basic forest legislation of many countries. The first forest reserves in the western United States and the first national forests in the East were set aside or acquired entirely for watershed protection. Some areas had practically no commercial timber on them at all. These attributes of forest land have all been recognized in policy formation, land planning, protection, and management. They have been considered, if only qualitatively, in estimating the effects of fire and other damages to forest cover.

Professional forestry thinking, however, has by and large centered upon timber values.[1] Our national efforts to improve the care and handling of forests and our concern over the problems and responsibilities of their ownership have related primarily to the question of timber supplies. Timber conservation has furnished the dominant motive for forest development policies and for public and private expenditures to protect, improve, and maintain the cover. Although other benefits have been cited in support of forest conservation proposals, it has been sincerely believed that, if forested areas were properly handled for continuous timber production, the noncommercial or "intangible" values would automatically be safeguarded. In the main, this belief is essentially sound, but in many instances critical climatic, soil, or other physical conditions may require considerable modification of cutting and skidding practices in the interest of maintaining forest stability.

The strong tendencies to identify the forest resource in terms of timber alone are understandable. Timber is the most obvious product of forest land, and commonly the chief source of its marketable wealth. Its negotiable value has constituted a key incentive to the ownership and operation of forest land for profit or revenues. On the other hand, the nontimber values, lacking financial appeal, have been neglected accordingly. The traditional outlook and predominant training of both European and American foresters in timber management and utilization can readily be rationalized on such grounds.

Today, however, the rapidly growing dependence upon the other values and the sharpening conflicts among various forest-using interests are rapidly creating a broader concept of forestry. This marked trend reflects the many doubts which have arisen as to whether timber considerations alone can safely assure the proper functioning of the forest as a whole. It has also stimulated a greater interest in more effectively expressing forest values previously regarded as "intangibles" or ignored altogether.

The specific effects of forest growth and the underlying ground cover upon fish and wildlife habitat, local climate, flood discharges, sedimentation, and water supplies are only gradually becoming known. Scientific evidence has been accumulated and public interest generated to such an extent, however, as to focus serious attention upon these aspects. Experimentation and research and investigations of damages originating on forest watersheds are raising serious questions on the adequacy of current standards of fire control; timber, livestock, and big game management; road and trail construction; and recreational uses and improvements.

Applicability of Current Valuation Methods

If timber production alone can no longer guide the course of forest policy, and if the desirable extent of public activity in forest rehabilitation, protection, and management is to be judged on broader grounds, how are the less obvious values to be taken into account? Can they also be measured in direct dollar terms for comparison with commercial forest products? Can the public interest in them be as readily ascertained as where timber is concerned? How can we assure that these values will be given adequate recognition in public policy determinations?

The answers must be sought in a sound understanding of the biological nature of the forest, with particular emphasis upon the interrelations among its several functions. A critical examination of the prem-

[1] This article is devoted primarily to forest-covered lands although the basic principles and problems discussed are generally applicable to brush and rangelands also.

The continued usefulness of Lake Mead, above Boulder Dam, is being imperiled by rapid siltation.

ises underlying the commonly accepted methods of forest resource evaluation is also required. These observations apply equally to the appraisal of timber and nontimber values.

Unlike timber, whose harvest provides immediate and direct gain to the owner, the benefits of the other services accrue largely to individuals remotely situated from the forest itself or to the general public. In some instances the landowner may derive income from them, as through the lease of grazing, hunting, or fishing privileges, or through the sale of water, as by a private utility. Nevertheless, even in such cases the public has a large stake in maintaining the forest resource because of its many indirect or secondary benefits. It yields timber whose utilization provides employment and community income and meets the national and world-wide need for wood; it offers recreation which is necessary to our national health and welfare, and also supports an important industry; it reduces erosion, flood, and sediment damages and in this way protects the security and welfare of the nation; it provides good water supplies which are vital to civilization.

The above values are commonly not recognized in American forest finance. For all practical purposes forest finance—as part of the broader field of private finance—has been developed as a guide to private investment in timber. As such, it fails to reflect the social values and even all the affected property values inherent in the timber resource, as well as the other forest resources.

The basic premises of forest finance include:

1. An assigned stumpage value. In the case of young growth or other presently inoperable timber, a future market value is usually assumed, based on current or predicted stumpage prices.
2. An assumed commercial interest rate.
3. The applicability of one of several purely mathematical formulas for determining present worth or future value, as the case may be. These premises are commonly applied whether the timber is publicly or privately owned. Where timber is publicly owned, a lower rate may be employed. With this single exception, however, the same premises and the same mathematical formulas are used.

Inherent weaknesses in the above premises include:

1. The uncertainties of predicting future stumpage values, especially for periods over 25 years.
2. The assumption that whatever interest rate is selected for computation purposes will remain applicable throughout the evaluation period.[2] In a dynamic society, interest rates, like other money prices, are affected by fluctuations in the many complex factors operating in a free economy. Also, the opportunities for continued returns on a given investment tend strongly to decrease with lapse of time.[3] Taking into account the ups and downs of the business cycle, it appears debatable whether capital investments over a long period earn anything like the returns indicated by compound interest calculations.
3. The assumption that equally good investment opportunities are available. So far as our land and water resources are concerned, it is questionable whether this assumption is valid in the face of nationwide timber and soil depletion.

The above comments apply commonly to the financial evaluation procedures now in general use, whether for public or private purposes. Where the public is involved, however, several additional elements enter in.

In the first place, discount rates based on individual time preference do not represent the public attitude towards national resource conservation. This attitude is best expressed as social time preference, which is something far different. Such preference is determined by how much society as a whole is willing to forego in material consumption today in order to provide for the needs of future generations. Questions of risk, profit, and other elements which affect the choice of individual time preference do not affect these consid-

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[2]Use of the annuity formula $\frac{Y(1.0p^a - 1)}{1.0p^a - 1}$ for determining the present worth of commercially immature stands avoids this difficulty in part by indicating an increasing rate of capital value accumulation as the stand approaches maturity, hence representing a decreased investment risk. Nevertheless, this formula too is subject to the weakness of employing a fixed discount rate over the entire period involved. It indicates an even lower value for small timber than the expectation value formula, a value, however, that is more in line with commercial rates.

[3]In one study of municipal reservoir sedimentation the discount rate used to arrive at present worth varied with the time involved. Where useful reservoir life ranged from 1 to 25 years, the rate was 4.5 percent; for periods from 26 to 100 years, 3.5 percent; and for longer periods, 2.5 percent. The viewpoint of this study was that of the municipal reservoir owners. Garin, Alexis N., and L. P. Gabbard. *Land use in relation to sedimentation in reservoirs*, Trinity River Basin, Texas. Bul No. 597, Tex. Agr. Exp. Sta., Jan. 1941.

erations. On the contrary, social time preference is more indicative of the risk to the national welfare of not providing today for the needs of tomorrow.

No one can be certain what quantitative rate—if any—would best represent society's time preference. Federal agencies are gradually adopting the yield rate of long-term Government bonds as an approximation. Some economists have suggested the applicability of a zero discount rate or even a negative rate for certain social purposes such as public health, defense, or education.[4] The zero rate at least is held to be equally applicable to the conservation of scarce or shrinking natural resources. The least that can be said for social time preference is that it provides a far more adequate expression of the public need for resource conservation—even where only timber is involved—than do any of the approaches based upon individual time preference.

The inadequacies of orthodox evaluation procedures become even more glaring when applied to the forest resource as a whole. From time to time efforts have been made to determine how much forest land should be retained nationally or within given regions to provide "economic" sources of timber supplies. Costs and returns of timber growing have been selected as the sole criteria. The extent to which the need for other services might make it desirable to retain or develop a forest cover, regardless of its ability to grow good timber, was overlooked. Yet in some instances these other services may be, and often are, of greater public importance than timber production. Forests are also necessary to assure more satisfactory water supplies, to reduce flood and sediment damages, to maintain favorable local climate, and to provide fish and wildlife habitat or recreational environment. Single-purpose evaluation of a resource which is fundamentally multiple-purpose in character can only lead to fallacious conclusions.

Watershed Evaluation Problems

The determination of the value of forest land as a biologic complex calls for a quite different approach than that indicated by commercial practice. It requires the adoption of an over-all viewpoint in which the several components of the forest and their interrelations are fully recognized. Such an approach rests on the biologically—and socially—sound premise that all the elements depend upon each other for their proper functioning. It recognizes that where watershed values are important, determinations of fire control and of timber management policy and expenditures must consider soil stability and desirable water flow conditions. Clearly other premises than those of private forest finance must be established and better methods developed for expressing the public interest in forest resource conservation.

Such methods are currently being developed in the watershed flood control survey program of the U. S. Department of Agriculture. The Omnibus Flood Control Act of 1936 which authorizes this activity states that the Federal Government should improve ". . . . navigable waters . . . . including watersheds thereof, ... if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected."[5]

Since 1938, when surveys first started, evaluation practices have undergone considerable evolution. The earliest evaluations employed commercial discount rates and computed cost-benefit ratios for individual measures although they were biologically interdependent. The less obvious direct and indirect benefits were usually ignored.[6,7]

The determination of damages and of costs and benefits from unified watershed remedial programs requires careful study of many factors contributing to erosion, floods, and sedimentation. "The damage appraisals must relate to the flood flow and sediment measurements of the hydrologists and geologists and in turn to the findings of foresters, soils specialists, agronomists, and others concerning upland soil and cover conditions. Measurements of soil and water losses are related to soil and cover types as influenced by climate and use, and in turn to the magnitude of flood discharges. . . . ."[7] Benefits derived from the program are based chiefly upon reductions in flood and other downstream damages, increased productivity of the treated watershed lands, and increased returns from water conservation. Costs include outlays of money, labor, and materials by all participants.

Damage Appraisals

Forest watershed lands influence flood flows and sedimentation through the manner in which they dispose of rain or snowmelt. The extent of this influence is determined by the interactions of climate, physiog-

[4] S. V. Ciriacy-Wantrup, "Private Enterprise and Conservation," *Journal of Farm Economy* 24, 1 (1942).

[5] Public Law No. 738, 74th Congress, Sec. 1.

[6] Bernard Frank, "Some Aspects of the Evaluation of Watershed Flood Control Projects," *Journal of Land and Public Utility Economics*, 18, 4 (1942).

[7] Bernard Frank and E. N. Munns, "Watershed Flood Control: Performance and Possibilities," *Journal of Forestry* 43, 4 (1945).

Social losses in floods and mudflows from overgrazed lands may far exceed returns to livestock operators.

This once-timbered area was denuded by fumes from copper-smelting operations. Private profits from improper exploitation of resources may often be obtained at public expense.

raphy, soils, and plant growth and its litter, as modified by human activity. The relative contribution of a drainage area to flood discharges depends in part upon the ability of the soil surface to take in water, upon the soil's capacity to transmit it downward, and upon the soil's water-holding ability. These factors vary with condition and density of the total plant cover, including litter and root systems, with soil structure and texture, especially as affected by compaction and organic matter content, and with depth to the impermeable layer. Run-off over the surface (overland flow) occurs whenever the rate of rainfall or snowmelt exceeds the rate at which the soil surface can take in the water. Surface run-off can also occur if more rain is falling than can be transmitted downward through the soil mass, causing a spill-over of the excess supply. Surface run-off is the most destructive form of water movement. It is largely responsible for sheet and gully erosion and the rapid formation of flood peaks.

Flood discharges can also result from subsurface flows, as from soils with an impermeable layer near the surface. Such soils may have high infiltration and percolation rates, but the permanent (capillary) storage capacity above the impermeable layer is soon used up, and the excess water may quickly collect into channels to build up peak flows. A major difference between such subsurface (or quick return) flow and storm surface run-off (or overland flow) is that the former infrequently causes erosion as it moves downward to the watercourses.

Good forest cover plays an important role in building up the soil's ability to handle precipitation. Surface run-off rarely occurs. The complete litter cover, the mass of living and dead roots of trees, undergrowth and ground cover, and the pore spaces and soil aggregates resulting from the high level of desirable organic activity create optimum conditions for infiltration, percolation, and water storage at all seasons. During the growing season, the soil storage capacity is maintained at the highest level by continuous transpiration losses. The flood control survey of the Potomac River watershed, for example, revealed that 17 inches (43 cm.) of water, or one-third of the total rainfall, transpired annually from well-stocked mature hardwood cover.

As the total forest cover and its soil deteriorate, their influence on flood flow reductions is materially decreased. Serious erosion, debris movements, and rapid peak flows may originate on forest areas containing good timber where, because of improper logging practices, repeated ground fires, or overgrazing by livestock or big game, the litter, humus, and mineral soil have been dissipated or compacted. Similar results generally obtain following the improper use of crop, pasture, or range lands.

Determination of the flood source areas requires a division of the watershed into various combinations of soil and cover. The relative flood contribution of each major soil-cover group to the flood flows recorded at stream gauges is arrived at by hydrologic procedures. These contributions are worked out for storms of given size and season. Damaging sediments are similarly traced back to their sources on the slopes and in the stream channels.

Flood flows occur at varying magnitudes and frequencies throughout the year and over a period of years. These variations—apart from the influence of watershed conditions—result from differences in amount and intensity of precipitation. No method has been discovered for predicting when future flood-producing storms will occur. For this reason, an established practice is to develop discharge-damage curves from past flood records to indicate the probable frequency of given-sized flows and the expected damages over a given period. Future average annual damages are generally estimated simply by dividing the total calculated losses for the period by the number of years.

No discounting is applied in this process; no calculations of present worth are attempted. To do so would require knowing when future floods were likely to occur. The present worth of future damages from, say, a 100-year flood would be very large or very small, depending, for instance, on whether it was assumed to take place next year, 50 years hence, or 100 years hence. Under such circumstances the use of refined evaluation procedures is clearly unwarranted.

Reservoir Sedimentation

Another type of damage is the loss of reservoir storage capacity by sedimentation. Reservoir surveys, or measurements of average sediment production rates of given streams, provide a basis for estimating average yearly depletion. This rate, when divided into the useful capacity of the reservoir, indicates the length

of its expected life. The usual evaluation procedure is to discount the future value of the losses over the period of years involved. Thus the longer it takes to silt up the reservoir, the less will be the present value of the loss. Similarly, the less will be the benefits from a sediment reduction program.

The major difference between current flood water and reservoir damage evaluation practice is that the latter employs compound interest calculations. Sedimentation rates, however, are as much the product of unpredictable rainfall as are flood flows. A period of frequent, heavy-sediment-producing storms may cause serious capacity depletion or increased operating costs long before the estimated time; a series of dry years following such depletion may reduce the volume of water in storage below the "safe yield." It is now known for instance that previously estimated sediment rates are too conservative. One reason for this is that watershed deterioration has become more serious and widespread than formerly. In addition, population growth plus increased per caput water use are already taxing reservoir supplies well beyond the allowances made at the time of construction.

It is true that storage reservoirs when silted up lose all or most of their economic value, whereas flood plain areas subject to recurrent water damages usually retain their values for crop production or other purposes. On the other hand, once a reservoir is used up, other sources of water supply must be developed —usually at greater cost and often of less effective service—if the dependent economy is to survive. Thus the fact that a reservoir has lost its usefulness by no means justifies the assumption that the dependent values are completely amortized and therefore need no further attention.

Existing and authorized reservoir sites, especially the larger ones, represent in most instances the best and cheapest of all possible alternatives. Their replacement, where physically possible, can be undertaken only at greater cost in labor and materials as well as in dollars. Also, the supply of major reservoir sites is definitely limited; the existing ones plus those included in projects now authorized will utilize the major portion of the total known reservoir sites in the United States.[8] For these reasons they should be classed as irreplaceable resources along with soil and other national wealth and considered accordingly in public resources evaluation practice. Reservoir sedimentation losses should therefore be determined in essentially the same manner as are floodwater losses, namely, on a simple average annual basis.

What index should be applied to sedimentation rates in determining the long-run public losses from depleted storage capacity? Should it be the actual construction cost? Should it be the cost of providing alternate sources of supply, if available? Or should it be the value of the economic activities made possible by the reservoir?

If it is accepted that reservoir sites, like soil, are irreplaceable resources, the use of either current or replacement cost would provide an inadequate, as well as an inconsistent, measure of the damages. Granting that from a private financial viewpoint it may be profitable for some time to come to replace used-up

[8]Carl B. Brown, "Aspects of Protecting Storage Reservoirs by Soil Conservation," *Soil and Water Conservation* 1, 1 (1946).

The public welfare may require land-restoration measures too costly for the private owner.

sites, the fact still remains that they are definitely limited in number and are steadily becoming more precious. Regardless of private financial criteria, public security plainly requires that reservoir sites be made to last as long as possible.

These considerations strongly suggest that damage determinations be based upon the long-time average annual gross income of the dependent economic activities. As income based on past and current conditions alone would be an inadequate measure, allowance would be made for the effects of future population growth and of higher per caput consumption up to the limit of the reservoir's capacity to produce services. The damage per unit of lost storage would be obtained by dividing the total capacity of the reservoir into the total amount of dependent income.

The above procedure would apply to all reservoirs irrespective of their size or length of life. It is believed that such an approach more nearly recognizes the accelerating national interest in conservation than any of the traditional methods now in vogue.

The case of Lake Mead on the Colorado River may be cited to illustrate the contrast between the two basically different methods for determining how much to spend to lengthen the life of a reservoir. This impoundment of 32,359,000 acre-feet (39,900 million m^3) was created in 1936 by construction of the Bureau of Reclamation's giant Hoover Dam at a first cost of $165,000,000. A major purpose is to supply irrigation water for 500,000 acres (200,000 ha.) of arid but fertile land in Arizona and California as the basis of an economy expected to support at least 125,000 people and to help meet the world's pressing food and fiber requirements. Additional purposes are to furnish drinking and industrial water for southern California, an area of some 4 million people, to provide flood protection for the Colorado River Valley, and to generate much needed additional hydroelectric power for the highly developed Pacific Coast regions.

Authoritative engineering estimates indicate that at current siltation rates the useful capacity of the reservoir will begin to diminish by 1985, or within 37 years, and that by 2079 or only 131 years hence, the

reservoir will have completely lost its usefulness except for the generation of run-of-the-river power. Present annual depletion in capacity is 137,000 acre-feet (169 million m^3)). The storage thus lost each year would be enough to irrigate some 35,000 acres (14,000 ha.).

According to one economic evaluation, along the usual orthodox lines previously discussed, the loss from the complete silting up of Lake Mead would total $470,000,000. This would consist of declines in farm land values, on-site values of dependent urban and industrial areas, unamortized investments, losses in value of firm power storage works, increased flood damages, population relocation costs, and operating income losses.

These losses, however, would occur over a period of years. Orthodox evaluation procedure requires that they be discounted to arrive at their present worth. For this purpose a three-percent compound interest rate (the present rate on long-term government borrowing) is applied. By this discount process the capital value of the loss shrinks to only $51,000,000 or around one-ninth of the future value. The conclusion reached is that the public interest would not be served by expending a total greater than this amount to prevent Lake Mead from becoming useless. The author admits, however, that if a lower discount rate were used or if silt rates should be greater than currently estimated, the present worth of the loss, consequently the justifiable expenditure to reduce it, would be higher.[9]

The above evaluation is arrived at by applying private economic criteria to a resource of immense social importance. As such, it rests upon the faulty premises already discussed.

By applying the public evaluation criteria suggested earlier in this paper, even in the inadequate medium of monetary values, we obtain a far different picture of the threat to Lake Mead and a far different conclusion as to the expenditure justified in forestalling this impending disaster.

The money loss from the public viewpoint may be determined very conservatively by considering the gross annual income of the reservoir-dependent economy. Assuming a gross income of only $500 per caput per year for the 125,000 people in the irrigated area alone, the annual loss over an indefinite time period would amount to over $62,000,000. This sum might be viewed as an upper limit to the annual public expenditure justified in the interest of avoiding or delaying destruction of Lake Mead. Undoubtedly, double this sum could be justified if all of the additional direct and indirect money values alone, especially those accruing to rapidly growing southern California, were properly evaluated.

No comprehensive physical surveys have yet been made to indicate precisely the capital expenditure and annual maintenance costs required to achieve a material reduction in sediment inflow from the 167,800 square miles (43.46 million ha.) in the drainage basin above Hoover Dam. However, the cost of an adequate watershed program can roughly be approximated by reference to a recent U. S. Department of Agriculture estimate for the Missouri Basin. This area of some 531,000 square miles (137.5 million ha.), or over three times the size of the Colorado above Hoover Dam, exhibits somewhat similar conditions and problems. Mean annual flow of the Missouri is some 0.14 cubic feet per second per square mile (0.0015 m^3 per second per km^2), and its annual silt production, 375 short tons per square mile (131 metric tons per km^2), as compared with a corresponding flow at the mouth of the Colorado of 0.09 cubic feet per second (0.0025 m^3 per second), and a corresponding silt production of 800 short tons per square mile (280 metric tons per km^2). Seventy-five percent of the Colorado's silt load, however, comes from an area of only 65,000 square miles ((16.8 million ha.), contributing only 10 percent of the total flow of the river.

The Department of Agriculture's estimate of the capital expenditure required to achieve and maintain satisfactory soil and water conservation on the Missouri River watershed amounts to $1,321,000,000, or about $2,500 per square mile ($960 per km^2). Allowing $3,000 per square mile ($1,200 per km^2) to meet the probably more critical problems in the Colorado above Hoover Dam gives a capital or first cost of around $500,000,000. Annual maintenance costs might run some 3 percent of this, or $15,000,000. This outlay would provide for a thoroughly integrated, multipurpose watershed remedial program consisting of such measures as soil and vegetal cover restoration or stabilization, stream bank and channel stabilization, control of gully or arroyo cutting, silt detention structures, water spreading and conserving facilities, and the land operation improvements and continuing conservation practices necessary to assure proper and permanent management of the forest, brush, and grassland areas.

Annual cost of such a program calculated without interest over a 100-year period would amount to $20,000,000, of which $5,000,000 would represent the annual value of the initial installation cost. This compares with the $62,500,000 annual income estimate for the irrigation economy dependent on Lake Mead. Assuming the necessary funds were made available, a program of the above type could be installed within 25 years, or 5 to 10 years longer than the period generally estimated for similar Department of Agriculture watershed projects.

The occurrence of normally rapid geologic erosion in some parts of the Colorado Basin makes it impracticable to attempt to stop all sediments at their sources. Nevertheless, it is conservatively believed that a thoroughly integrated, comprehensive watershed program would reduce siltation of Lake Mead by at least 50 percent. Even so, the above expenditure would be fully justified in that both the remaining useful and total life of the reservoir would be doubled and the productivity and earning power of the dependent economies extended accordingly.

Natural Storage Capacity

The same line of reasoning applies to losses of natural storage capacity caused by erosion or other forms of damage to the soil. The water-holding capacity of the soil mantle, especially the upper layers, far exceeds the capacity that could be artificially created by the largest conceivable program of reservoir construction. Hence the maintenance of natural storage is of the utmost national importance.

[9] John B. Bennett, *Economic Aspects of Siltation of Lake Mead*, Memorandum, U. S. Department of Interior, 28 January 1947 (mimeo).

Forests as Water Supply Sources

In addition to their functions in the reduction of flood and sediment damage, forest lands are also important water supply sources. The problem of determining the worth of a forested watershed for such purposes does not usually arise so long as it produces desirable streamflow. Commercially speaking, the watershed area may be said to have a "stumpage" value determined by the difference between the average selling price of the finished water and its production cost. Some attempts have been made to evaluate the water supply services of forested drainages on that basis. This approach, however, is entirely inadequate from the water user's viewpoint. It provides no sound criterion for judging how much could justifiably be expended to assure the proper functioning of the watershed.

A more realistic approach would be to consider the damages — poor distribution of seasonal flow, lower quality water, higher treatment costs, reduced dry season hydroelectric power output, cost of necessary works to provide substitute storage for water and sediment, etc.—that might be expected if watershed conditions were not adequately maintained. (The same approach could also be used to determine what uses in addition to water production could be safely permitted.) As in the case of reservoir sedimentation, community dependence indicates that probable damages should be estimated on the basis of all dependent values at stake, and without benefit of compound interest. The jutifiable outlays so determined would probably exceed the actual expenditures necessary to assure the stability of the watershed, especially if it were already in good condition; but this method would provide a far better index of the public's estimate of water supply values than the narrow "stumpage" approach.

Benefits Evaluation

When the forest resource is performing its multiple services at full efficiency, the flow of benefits is immediate and continuous. Cost-benefits comparisons can be made directly, especially if costs are primarily of a uniform annual nature; but where the forest resource has been impaired, the benefits from its rehabilitation will be delayed according to the degree of impairment. Where deterioration has progressed so far as to upset the soil-cover-water relations of the area, its restoration may require relatively large capital outlays.

The application of private finance procedures to such situations inevitably leads to the conclusion that it does not pay to invest in the required watershed improvement measures. The initial capital and early maintenance costs are too heavy; benefits are long in coming and shrink alarmingly when reduced to present worth. In addition, most of the benefits may be of a character which will produce no visible returns to a private owner. For these reasons the major responsiblity for restoring badly eroded and otherwise decimated areas has largely fallen upon the Government.

The fact that society as a whole is expected to undertake such "profitless" activities further militates against the use of compound interest in determining the expected public benefits. Yet calculations employing the methods and rates of private finance have resulted in recommendations against watershed remedial programs because they were "uneconomic."

"To rule the mountain is to rule the valley."

Besides suffering from the weaknesses previously mentioned, benefits calculations of this sort rest on several unsound premises: first, that if the work is deferred, no increased damages will occur in the future; second, that it will cost society—in terms of labor and materials—no more to do the work in the future; third, that the need for resources will be no greater than it is today.

Dr. Lowdermilk has this to say on the subject: "Today we are prone to measure the fate of land solely in economic terms of present market prices. If it does not pay under present economic give and take, we look upon destruction of land with complacency. This complacency grows out of a false assumption that there is an abundance of land; that if we destroy this farm, we can go west to take up new land. But in the long history of mankind, economics is like the weather —it changes back and forth. It changes far more rapidly than climate changes. But the changes in land that are brought on by soil erosion are not like economic changes. They are cumulative in their destruction and in the effects of eroded materials. Such changes are not reversible. It matters little what the economics were that brought on soil depletion and destruction if the land is destroyed for further growing of crops. The fact is that when soil is gone it is costly beyond reason to restore the remaining material to a state of production. Commercial economics may ac-

tually set in motion processes that cannot be reversed —may impoverish the land. Herein is an insidious hazard to our land. For under profitable business economics the land of a nation may be despoiled.

"In our stewardship of land, therefore, we must look beyond commerce of today to the economics that determine the future of our people. If economics will justify nothing else than the destruction of land which is the heritage of our people, something is wrong with the economics rather than with the land."[10]

Judging by the fact that our land and water resources are being damaged more rapidly than they are being reclaimed, it is inconceivable that foresters or other conservationists should accept the principles or methods of commercial finance as a basis for public resource evaluation. Simple methods based on knowledge of the physical and social factors involved would be more in keeping with the objectives of conservation.[11]

Recreation and Wildlife Values

The evaluation of forest land for recreational use or for fish and wildlife production is another problem of growing importance. Efforts are currently being made to measure these values either to indicate limits of justifiable public expenditure or to appraise the damages from land and water abuse or harmful engineering developments.

Thus far, such evaluations have been confined to given units or localities. No realistic attempt has yet been made to take the national aspects into account. That these resources are of large social and economic significance is thoroughly established. Yet the fact that this significance derives from the part played by each locality in maintaining a desirable national balance among all types of areas has been completely overlooked.

Only from a national viewpoint can we best judge how far to go in safeguarding the recreational qualities of a given area. Otherwise it will be difficult, if not impossible, to express the full extent of the public interest. This approach seems particularly called for where conflicts arise with local projects, such as dams, whose direct money benefits outweigh the local returns from recreational use, fisheries, or wildlife. The proper appraisal of such resources would call first of all for a determination of the national need for them. This would take into account increased population growth and expected increases in per caput use over, say, a 100-year period in the future, and also the extent to which the existing areas or facilities are sufficient in amount, quality, and location to meet both present and future demands. Finally, specific provisions would be made to fill in whatever gaps were revealed. Such an over-all consideration would aid materially in arriving at sound conclusions as to the importance of retaining recreational areas in given localities.

The need for a unified approach in resolving conflicts of this kind may be illustrated by the effects of proposed irrigation projects upon cold water fish such as trout. When weighed on a purely local basis, the scale is tipped heavily in favor of developments which will impair or destroy the habitat. The money returns from irrigated lands are usually greater than those which could be derived from maintaining trout environment. Yet from a national point of view the fact that suitable trout streams are becoming scarcer despite a growing demand for them, and that large expenditures are being incurred for this type of fishing, would indicate that other factors besides local returns should be weighed. As most of the finest remaining recreational, fish, and wildlife areas are in public ownership or under public control, it would seem the better part of wisdom that costs-benefits appraisals of engineering developments recognize all conservation interests. Otherwise there is grave danger that our finest recreational areas and our finest fisheries will be whittled down bit by bit in one section of the country after another. Clearly the national interest requires a still closer co-ordination between land and water conservation agencies than is yet in evidence in these fields.

Summary and Conclusions

Sound evaluation practice requires that the procedures applied fit the purposes intended and square with the underlying physical facts. Private finance methods fail in both respects so far as resource conservation is concerned. While such methods may suit the purposes of the private owner, they fail to consider the general public welfare. When applied to public resource evaluation, they require the setting up of artificial and unrealistic distinctions. They omit or give wholly inadequate weight to values not readily susceptible to commercial appraisal. Their complex calculations give a false semblance of accuracy to the results obtained.

Conservationists who are concerned with the broader values inherent in forest lands should no longer be content with the premises or calculations of private finance as a measure of the limits to conservation effort. Instead, they should develop their own principles and methods or at least insist that whatever methods are applied rest on sound biologic and social principles. Statistical procedures used with care and discrimination would be helpful, but the complex interrelations involved and the necessity for forecasting future events call for the use of informed and intelligent judgment in arriving at the final answers. In view of all circumstances, the straight-line average annual approach is recommended as a reasonable solution to the problem of evaluating natural resources and the effects of conservation activities in the public interest.

[10] Walter C. Lowdermilk, "A Hope for the Future," *Soil Conservation* 13, 2 (1947).

[11] Restoration costs and benefits might be summed up for a given period of years—100 years as a minimum from the public point of view—and the totals compared directly. Or, if average annual values were desired, the respective totals would be divided by the period of years involved.

Illustrations for this article were provided by courtesy of the U. S. Forest Service and the U. S. Bureau of Reclamation.

Improved Pulp Cooking Methods

By E. C. JAHN

THE principles followed in the cooking of wood have remained the same since the inception of the chemical pulp industry. The sulphite and sulphate processes are the standard methods followed. Other methods are of minor importance from the point of view of the quantity of pulp produced.

However, many improvements in technique have been developed during recent years. These have resulted in improved quality and yield, together with reduction in time, labor, chemicals, and maintenance cost. There is also a steady trend towards the pulping of more species of wood and of other cellulosic materials. The work of the United States Forest Products Laboratory in this field is particularly noteworthy.

In general, for the pulping of hardwoods and little-used softwoods, no radical departure from the standard sulphite and sulphate processes are necessary, although certain variations are desirable. It is generally recommended that widely different woods be pulped separately and that other species be pulped in mixtures of a constant ratio of composition.

Investigators continue to probe into the chemistry of the sulphite and sulphate processes. Complete understanding of the mechanism of these processes, however, awaits the solution of the lignin problem. Much progress is being made in research on these problems by Hägglund and Erdtman in Sweden, by Brauns, Harris, McCarthy, and others in the United States, and by other lignin chemists throughout the world.

Interest in investigations of other means of pulping cellulosic materials continues. The chlorine and the nitric acid processes have become established in some places, the former particularly for the pulping of straw and plants other than wood. At present, the most active new development outside the standard pulping processes is in the field of semichemical pulping. Interest in semichemical pulping has grown considerably during the past few years and already an appreciable volume of semichemical pulp is being produced.

The Sulphite Process

In the sulphite process the most notable trend in cooking practice has been the use of higher acid concentrations. A total sulphur dioxide content of 7-8 percent is not uncommon; in fact, the normal trend seems to be to cook with liquors containing approximately 7 percent free SO_2 and 1.2 percent combined SO_2. An extreme of 10 percent free SO_2 is used at one mill. Some mills use a higher combined and a lower free percentage but maintain the total SO_2 at around 7 percent. In one example the acid composition has been changed from 3.3 percent of free and 2.1 percent of combined SO_2 in 1939 to 4.5 and 2.6-2.7, respectively, in 1945-46.

The maximum free SO_2 content depends upon the allowable digester pressure and the acid system employed. Stronger acid permits faster cooking and a lower maximum cooking temperature, which result in a higher yield of pulp. To use acids of high SO_2 content requires digesters with strong shells to keep the additional sulphur dioxide in solution. For a given pressure there is a maximum efficient SO_2 content. For example, at 95 lb. per sq. in. (6.3 kg. per cm^2) maximum pressure, the efficient free SO_2 is 6.5 percent, according to Holzer. Normal cooking pressures have been raised to 80-85 lb. per sq. in. (5.6 to 6 kg. per cm^2) gauge pressure.

Investigations have shown that an increase of combined SO_2 up to an amount corresponding to 5 percent of the weight of the wood slows the rate of cooking, which decreases the attack on the cellulose and thereby increases the yield of pulp. The increased concentration of the bisulphite ion reduces the partial pressure of the sulphur dioxide. Higher combined SO_2 contents than 4.5-5.5 percent of the weight of the wood are needless.

The use of stronger cooking acid, lower maximum temperatures, and higher pressures has brought about improved pulp yields and quality and has reduced the time of the pulping operation. These changes in cooking have been accompanied by other improvements in technique including (1) the use of hot acid, (2) chip packing, (3) digester circulation with or without outside heating, and (4) better digester control by instrumentation.

Most of these techniques are interdependent. For example, high acid concentration requires a hot acid system. Chip packing and forced circulation go hand in hand. External heating permits better instrumentation. In fact, best results are obtained when all of these techniques are used and properly co-ordinated.

Hot acid systems have become common and permit the use of higher acid concentrations. The acid from the Jenssen system is passed through a pressure tower in which it is brought into contact with cooled burner gas at pressures up to 10 lb. per sq. in. (0.7 kg. per cm^2). This acid is further fortified by the chemipulp system, using digester relief gases under pressure. In Scandinavia and on the North American continent a system for the recovery of accumulator overgas has come into use. The overgas from the low pressure accumulator goes to two absorption towers in series where it is absorbed by raw acid fed from the top. These absorption towers relieve the acid plant of fluctuations and make possible a high acid concentration as well as a saving of sulphur. The increased acid temperature, which is possible by the use of these recovery systems, results in a substantial saving of steam. The modern acid plant and digester relief system are practically automatic by instrument control.

The use of hot acid (usually 75°-90° C.) permits more rapid penetration of the chips. Precirculation with the hot acid before steaming is practiced by some mills and is claimed to secure nearly complete pene-

tration with the strong acid by overcoming the initial dilution caused by the moisture in the wood. Precirculation also removes air from the wood. Other advantages claimed from precirculation of hot acids are increased uniformity of pulp and reduced screenings, decreased cooking temperature and time cycle and increased yield.

Chip packing is widely used in Scandinavia and is coming into greater use in North America. Proper chip distribution or packing increases the amount of wood per digester charge and hence increases the daily pulp output. One mill reports that the pulp produced per cooking increased from 12.88 tons to 14.76 tons by the installation of mechanical chip distributors. Improved steam and sulphur consumption also resulted.

Forced circulation permits increased chip packing. In fact, chip packing is desirable where circulation is used, since the even distribution and density of the chips prevents channelling and, vice versa, forced circulation is desirable when a digester is heavily charged by the use of chip packers.

The use of indirect heating, together with forced circulation, is common in Scandinavia and is becoming more widespread in North America. External heating permits closer digester control by instrumentation. The advantages of hot acid systems, chip packing, forced circulation, and outside heating can all be combined, resulting in a substantial saving of steam and sulphur, greater yield and output, and improved pulp quality. The steam saving is around 35 percent, the yield increase about 5-6 percent, and the daily increase of output as much as 35 percent.

There is a tendency towards full automatic control in sulphite cooking. With uniform wood automatically weighed and of known moisture content, with uniformly controlled acid, and with outside heating and circulation, automatic digester control is possible. Where wood of diverse species and varying moisture content is used, the control is partly automatic and partly manual.

Stainless steel valves and fittings have been in use for some time. A recent development, however, is the building of a stainless steel digester for commercial operation.

The most notable innovation in sulphite cooking procedure has been the use of ammonia, sodium, and magnesium bases in place of the usual calcium base. The ammonia base process was developed by Cross and Engelstad and put into operation in Norway about 12 years ago at a mill producing ammonia from atmospheric nitrogen. An acid of about 8 percent total and 1 percent combined SO_2 is used. There are two mills in the United States which have the ammonia process, both installations being recent. The advantage of the ammonia process is that it permits easy disposal of the waste liquor by evaporation and by burning the dissolved organic matter as a fuel.

One mill in Sweden uses a sodium base sulphite liquor. Chemical and heat recovery are carried out in conjunction with the sulphate mill's soda plant. A new mill in Canada has proposed the use of a similar system.

The magnesium base system is to be put in operation at a plant in the United States. Hatch, in a series of articles, points out that the magnesium base sulphite process has the advantage of the relatively simple recovery of heat and the original chemicals without the troublesome scale problems encountered in evaporating waste calcium base liquors. The organic matter can be converted to process steam and power, and 90 percent of the magnesium and of the sulphur used can be recovered.

The soluble bases are said to give pulps with fewer screenings and a higher unbleached brightness. The time for penetration and diffusion is also claimed to be less important, so that the cooking time can be appreciably shortened. Chemical recovery and the elimination of the waste liquor problem, however, are the two most important advantages of the soluble bases.

During the war the sulphite cooking technique was modified in Scandinavia to produce fodder cellulose and to give waste liquors with a high sugar content for alcohol production. These modifications were only of wartime duration.

Continuous sulphite pulping has been investigated. The theoretical aspects of the chemistry involved indicate that such a process can be developed, although the engineering difficulties are great.

The production of sulphite semichemical pulp is being studied by a number of mills. The principle involved is to prepare a raw or partly cooked stock, which is then de-fibered by a refiner. High yields can be obtained in this way, giving a pulp suitable for certain types of papers.

The Sulphate Process

In the sulphate process the cooking treatment given the wood depends upon whether a bleaching or an unbleached grade of pulp is desired. For producing bleaching grades it has been the general practice to cook comparatively soft stocks (TAPPI [Technical Association of the Pulp and Paper Industry] Nos. ranging from 12 to 18). There is some indication of an extension in cooking time to level the nonuniformity in cooking. Most mills making bleached pulp are designed for a cooking time of about four hours. In Scandinavia, uniformity for both bleaching and unbleached grades is achieved by the use of forced circulation and indirect heating, and there is a trend in this direction in the United States of America. For bleaching grades there is a tendency to increase the chemical ratio and some mills are using a larger liquor/wood ratio, including mills cooking for stronger grades of pulp. Where indirect heating and circulation are employed, it has been shown that lower sulphidity ratios (15-20 percent) are adequate.

For bleaching grades some mills are no longer cooking to such soft stocks as formerly. There is also experimentation on the cooking of very hard stocks, almost chippy in nature, followed by refining and the use of exceedingly large amounts of chlorine, up to as much as 30 percent, in the bleaching operation. The high chemical cost is believed to be offset by the increased yield.

For both bleaching and unbleached grades, there is now an extensive use of hardwoods in the kraft process, particularly in the southern United States. For the finer grades of paper, mills usually cook the hardwoods separately, but for tonnage products such as liner, board, etc., the species are cooked together.

For semibleached and unbleached grades of pulp, there is a trend toward higher yield pulps, especially for kraft liner stock. This is brought about by short

cooking schedules. Cooking cycles of only one and one-half to two hours are used by some mills. This trend toward higher yields is carrying over into the semichemical range, where the incompletely cooked brown stock is further refined mechanically by disc refiners.

Another trend is towards larger digesters equipped with forced circulation and indirect heating. Chip packing is also employed more widely. Recording and controlling instruments are now being widely used. These improvements have helped to increase quality and uniformity and to aid in steam economy. There is also an increased use of alloy steels, and alloy steel digesters have recently been made.

Nearly all new installations have multiple-stage vacuum washing, except where raw semichemical pulps are made. The latter handle better in diffusers. Commonly, three to four stages are used in vacuum washing, but recently a five-stage system has been installed. The chemical loss has been cut to 40-50 lb. (18-23 kg.) of sodium sulphate per short ton of pulp by vacuum washing. Some mills with few stages are increasing the number of stages. The use of blow tanks is standard practice in vacuum washing installations. This facilitates the recovery of the blow steam and provides an ample supply of hot water for the washing stage.

The increasing use of Cottrell precipitators in the recovery operation is, together with multiple-stage washing, an important factor in the reduction of chemical losses. Lime recovery has also improved during the past few years. The fresh lime addition is usually below 50 lb. (23 kg.) per short ton of pulp and some mills claim it to be as low as 10-15 lb. (4.5 to 6.8 kg.) per short ton of pulp.

Continuous kraft pulping is still being investigated, but operations remain on a small scale, essentially the pilot plant type, both in the U. S. A. and in Sweden.

Prehydrolysis by dilute sulphuric acid was developed in Germany during the early years of the war for beech and other woods. The operation is claimed to give a pulp of high alpha content especially suitable for staple fiber and rayon. Less alkali is required in the bleaching operation and the yield losses on bleaching are low. The acid hydrolyzate contains sugars claimed suitable for torula yeast production or for alcohol. One Scandinavian mill using pine has installed a prehydrolysis stage.

Semichemical Process

Semichemical pulping is generally defined as a two-stage pulping process, involving chemical treatment to remove part of the lignin or fiber-bonding substance and mechanical refining to complete the separation of the fibers. Under this definition a wide variety of pulping methods could be included, such as, for example, the steaming of wood chips under pressure followed by mechanical refining in interplane refiners. Strictly speaking, this method, which is used to produce wallboard stock, is a semichemical process, since water at elevated temperatures and pressures has a chemical and plasticizing effect on wood. Generally, however, the semichemical process is considered to include pulping by a chemical pulping agent such as sulphite, soda, sulphate, neutral sulphite, sodium carbonate, and various mild alkaline reagents. So-called high-yield sulphite and sulphate pulping o tions, giving 55-60 percent yields of pulp, are usually considered as producers of semichemical pul even though the brown stock requires mechanical de fibering.

The neutral sulphite semichemical process, developed at the United States Forest Products Laboratory at Madison, Wisconsin, and reported in 1926, is the most widely used semichemical process today. This process is particularly suited for hardwoods, since an especially strong sheet is produced from these short-fibered woods. Furthermore, recent developments have shown that it is possible to produce a bleachable pulp and, by conventional chlorine-hypochlorite bleaching, produce a fully bleached hardwood pulp of exceptional strength and high yield. The bleached pulps are stronger than the unbleached and are similar in many respects to softwood sulphite pulps. Bleached pulps in yields of 58 percent from aspen have been reported by Simmonds and Kingsbury and 60 percent from birch by Phelps. One mill is expected shortly to produce bleached semichemical aspen pulps for book paper.

The semichemical process is undergoing most rapid development in the southern United States, with hardwoods being mainly used. A variety of techniques have been developed, but neutral sulphite and modified sulphate liquors are used for the most part. Interplane grinders of various manufacture are used for the second stage of pulping. From the southern United States oak is being pulped by the hard kraft semichemical process for corrugating board.

Work on a new type of semichemical pulp has been reported by Libby at the New York State College of Forestry. Pulpwood logs are first chemically treated under pressure and then ground by conventional stone grinders. Pulps of very high strength values and high yields from hardwoods are reported.

Recent investigations on the recovery of chemicals from semichemical spent liquors may lead to the industrial development of chemical recovery processes. Such a development should reduce costs and result in increasing the expansion of semichemical pulping.

Other Pulping Processes

Research interest has been maintained in the possibilities of pulping wood and other cellulosic materials by entirely new techniques. The use of the Pomilio chlorine process has expanded, especially in Italy, the Union of South Africa, the Philippine Republic, and Argentina, where it is mainly used to pulp cellulose materials other than wood. A plant using a modified chlorine process is now planned for Mexico.

Research on the nitric acid process has been greatest in Germany (for beech), Japan (for straws and wood) and in the U. S. A., where Aronovsky and co-workers have carried out extensive investigations on the nitric acid pulping of agricultural residues.

In Germany a sodium chlorite pulping process was developed by Jayme and others. In the U. S. A. at the Institute of Paper Chemistry, Wise has been studying the step-by-step removal of lignin by sodium chlorite.

The work of Ritter and his associates at the United States Forest Products Laboratory on the holocellulose process has been of considerable significance. Indus-

trial adaptations, especially in bleaching, are being developed.

Considerable research on the removal of lignin by organic reagents has been reported in the literature. The processes studied, however, appear to be too expensive for practical application.

Conclusions

The principal new developments and trends in the cooking of wood may be summarized as follows:

1. Increased yield and increased digester output in the sulphite and sulphate processes by chip packing and shorter cooking cycles.
2. Improved quality of sulphite and sulphate pulps by use of liquor circulation systems, outside heating, and instrument control.
3. Use in the sulphite process of high acid concentrations, together with the hot acid system, improved acid-making methods, and automatic control of acid making and sulphur dioxide recovery.
4. Use of metal bases other than calcium in the sulphite process.
5. Improved chemical recovery in the sulphate process by better pulp washing, the use of Cottrell precipitators, and improved soda house techniques and controls.
6. Adaptation of the sulphite and sulphate processes to a wide variety of species, especially hardwoods and new coniferous woods, Douglas fir, *Pseudotsuga taxifolia*, and western red cedar, *Thuja plicata*.
7. Development of a wide variety of techniques and the use of various chemicals in the semichemical process, and the development of semichemical bleached pulps.

(See pp. 88-91 Recent References on Improved Pulp Cooking Methods.)

An Estimate of the Shrinkage of Africa's Tropical Forests

By H. L. SHANTZ

IN "The Disappearance of the Tropical Forests of Africa," Aubréville[1] points in striking terms to the many means by which the forests are gradually shrinking. The loss of forest area to the grasslands is due largely to the clearing done by native populations and to destruction of forests by fire.

It seems possible to estimate with some degree of accuracy the amount of this destruction. In Africa there are three forests which have lost area to the grasslands and in each of them this process of destruction is going on at this time. The tropical rain forest is losing to the high grass savanna, the temperate rain forest to the mountain grassland and the dry forest (monsoon forest) to the acacia-tall grass savanna.[2]

The boundary line or ecotone between the tropical rain forest and the high grass savanna is typical of a retreating forest line. The scattered clumps of trees throughout the savanna are remnants of what seems from an ecological point of view to have been continuous or nearly continuous forest. The fact that climate, soil, and crop potentiality are the same except for the microclimatic effect of light and wind movement also supports this view.

Beyond the high grass savanna, which is probably derived from the tropical rain forest, lies the dry forest. This forest in turn can with great difficulty be separated from the acacia-tall grass savanna. Where the dry forest is broken into clumps or park land areas or single trees, much the same type of ecotone is presented as that between the tropical rain forest and the high grass savanna. Often the trees disappear entirely, leaving tall grass, but generally the more fire-resistant trees are scattered over the grassland. Natives choose land marked by the clumps of trees for cropland, cut and burn the trees, and plant the crop in the soil fertilized by the ash.

At high elevation in a temperate climate, the temperate rain forest is shrinking rapidly. The soil is productive of a great variety of agricultural crops and some of the region is densely populated. Cropland when abandoned and burned over reverts, not to forest, but to bracken and to grassland. Here, again, small areas of forests persist where naturally protected, and there is every indication that forests once occupied much, if not all, of the mountain grassland area.

It is evident that if this process of gradual destruction of the forests of tropical Africa is not halted or turned back by afforestation methods the forests will give way entirely to grassland or savanna.

It seems reasonable to estimate the amount of this shrinkage by comparing the area of the forest with

[1] Aubréville, André Marie A., *Unasylva*, Vol. 1, No. 1 (July-August 1947), 5-11.

[2] Shantz, H. L. and C. F. Marbut, *Vegetation and Soils of Africa, Research Series No. 13*, New York: American Geographical Society, 1923.

the ecologically equivalent grassland derived from it. By this means we can express numerically what is left and what has probably been destroyed by present practices.

The tropical rain forest is losing land to the high grass savanna and the area of each is as follows:[3]

Tropical rain forest	233,000,000 hectares
High grass savanna	381,000,000 hectares
Total (potential)	614,000,000 hectares

The ratio of actual forest to potential forest is 0.38. In other words, the present tropical rain forest is shown to be only 38 percent of what it may have been originally.

In the highlands the temperate rain forest is losing area to the mountain grassland and the area of each is as follows:

Temperate rain forest	24,900,000 hectares
Mountain grassland	83,100,000 hectares
Total (potential)	108,000,000 hectares

The ratio of actual forest to potential forest is 0.23. The present temperate rain forest is shown to be only 24 percent of what it may have been originally.

On the drier side of the high grass savanna in an area with a pronounced dry period is the dry forest. This forest is losing land to the acacia-tall grass savanna. The area of each of these types is as follows:

Dry forest	273,000,000 hectares
Acacia-tall grass savanna	526,500,000 hectares
Total (potential)	799,500,000 hectares

The ratio of actual forest to potential forest is 0.34. This indicates that the present dry forest is only 34 percent of what it may have been originally.

These areas can be combined to give an over-all picture of the forest condition in tropical Africa.

	(*Area in hectares*)	
	Actual	Potential
Tropical rain forest	233,000,000	614,000,000
Temperate rain forest	24,900,000	108,000,000
Dry forest	273,000,000	799,500,000
Total	530,900,000	1,511,500,000

It seems reasonable to say that in tropical Africa today the forest area is about a third of what it could have been except for the ravages of fire and the destructive practices of the agriculturists.

These figures are based on planimeter readings from equal area maps and are probably as accurate as can be obtained without actual vegetation surveys. Such surveys would give more accurate details but it is doubtful if they would appreciably modify the general conclusion.

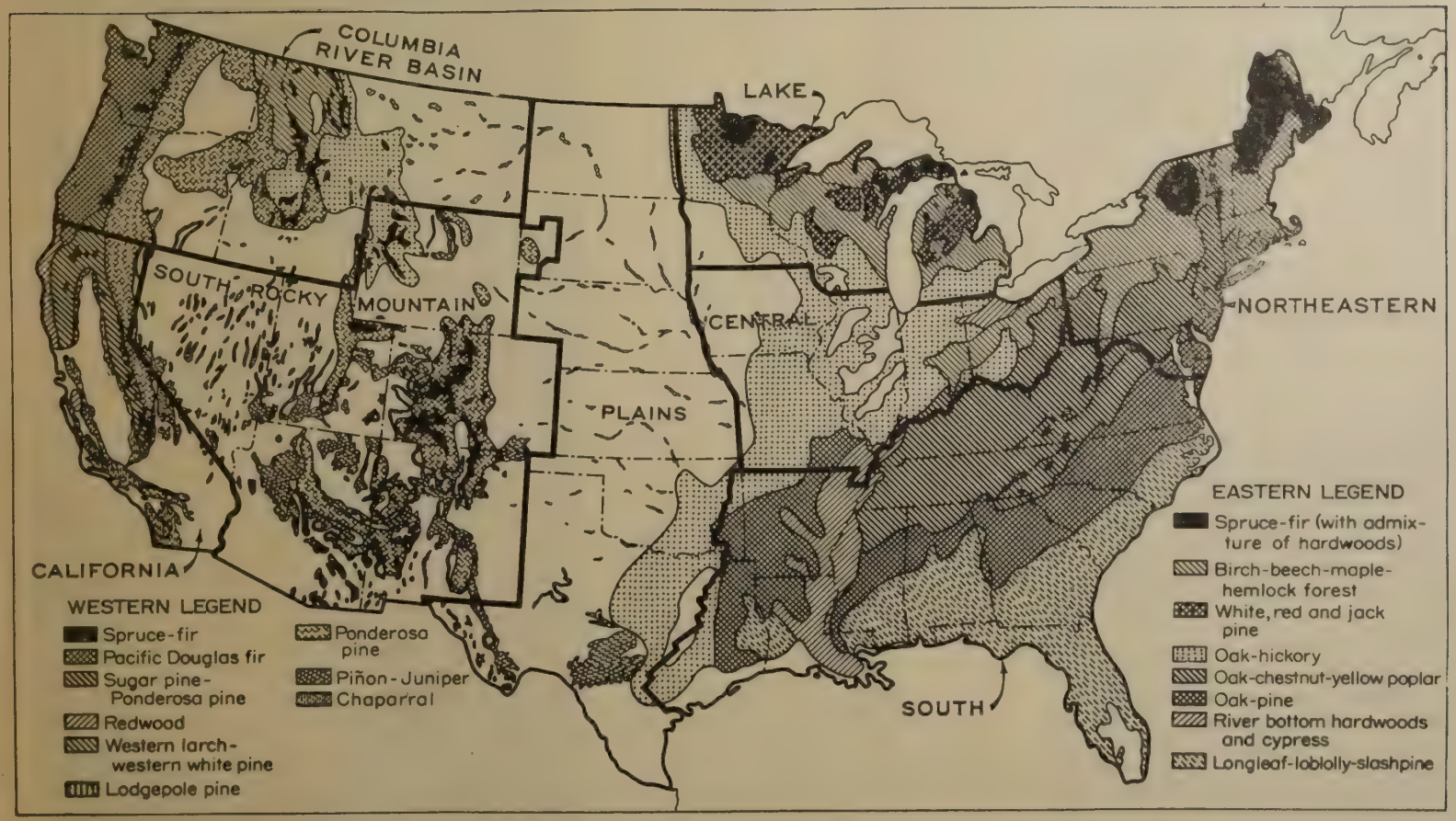
The present forests of tropical Africa occupy about 531 million hectares. The adjacent savanna and grasslands derived largely, if not wholly, from the destruction of the forests now occupy about 991 million hectares, most, if not all, of which is capable of producing forest under proper management.

The general conclusion is that the forests of tropical Africa, which are shrinking rapidly at the present time, have already been reduced to a third of what they probably were originally.

[3]Shantz, H. L., "Agricultural Regions of Africa," *Economic Geography* Vol. 16 (1):1-47, Vol. 16 (2):122-161, Vol. 16 (4): 341-389 (1940); Vol. 17 (3):217-249, Vol. 17 (4)353-379 (1941); Vol. 18 (3):229-246, Vol. 18 (4):343-362 (1942); Vol. 19 (1):77-109, Vol. 19 (3):217-269 (1943).

Raft of okoumé logs floating down a river in Gabon, tropical Africa

CHART 1. FOREST REGIONS AND PRINCIPAL FOREST TYPES



Organization of Research in the U. S. Forest Service

By EDWARD I. KOTOK

ORGANIZED research in the United States on forestry and forest products was first undertaken by Federal Government agencies. Although today much research of this kind is conducted by universities, professional schools, business enterprises, and industrial organizations, the Federal program remains both largest in size and most comprehensive in scope. This article therefore considers primarily the activities of that program and particularly those of the Forest Service and its organizational setup.

Historical Development

The effective management and utilization of forests and ranges in the United States, as elsewhere, must rest upon a basis of scientific fact such as can be obtained and maintained only through continuous research. Forestry research by the Federal Government was first authorized by the United States Congress in 1876, with a small appropriation for forestry investigations by the Department of Agriculture. This was 15 years before the establishment of "forest reserves" from the public domain and 21 years before provision was made for protecting and utilizing these reserves, later called "national forests." Investigations were carried out during the ensuing 50 years on a small but gradually increasing scale in the fields of forest economics, dendrology and silviculture, forest products, forest influences, forest fire control, forest insects and diseases, and range utilization and management.

By 1908 it had become recognized that in both forest administration and in forest research the natural forest regions, of which there are about a dozen in the U. S. A., would best serve as the unit of work. Thus, in 1908 six regional administrative offices were set up in the western United States and the first regional forest experiment station was established in the Southwest. This regional organization of forest research has, as later explained, continued and been expanded and refined. Chart 1 shows these major forest regions.

In 1910 another basic organization concept was formed and given effect in the establishment of the Forest Products Laboratory in co-operation with the University of Wisconsin at Madison. This, in contrast to forest experiment stations, attacked forest products research from the national rather than regional basis. This pattern, too, with some recent increase in detailed regional research, has continued in full effect.

By 1915 the growing importance of forest and forest products research resulted in the setting up of a Research Branch in the Forest Service, co-ordinate with the main units of administration at that time. Forestry research received a major impetus about 20 years ago, when the United States Congress, after considering an exhaustive analysis prepared by a committee of the Society of American Foresters, passed the McSweeney-McNary Forest Research Act on 22 May 1928.

Legislation

A co-ordinated Federal forest research program was authorized by the McSweeney-McNary Forest Research Act of 22 May 1928. This Act also established specific authorizations for appropriations for different lines of work over a 10-year period and authorized such additional sums as might thereafter be necessary. This authority is adequate to take care of the research program described in this article. The Act authorized the establishment of some 14 regional experiment stations within the continental United States, and one each in Alaska, Hawaii, and the West Indies dependencies.

In 1938 the United States Congress, through a Joint Committee on Forestry, after an exhaustive study, again called attention to the fact that "From the forest-resource standpoint, America is in transition from a philosophy of exploitation to one of planning and applying sustained management and orderly utilization. The knowledge necessary to accomplish this transition is as varied and complex as are the forest conditions and their economic and social relations. Organized research is the surest, quickest, and most economical way of obtaining the necessary information."

At the end of World War II, the U. S. Congress again asked for a fresh look at the situation and for the preparation of a national plan of research to serve as the backbone of the forest and range program of the United States. The war had spectacularly demonstrated the importance of our dwindling supply of natural resources and the need for technical knowledge to ensure the production and utilization of adequate supplies of industrial forest materials. It had emphasized that much better management and more intensive efforts would be needed to provide forest raw materials sufficient for future needs and at the same time to meet immediate requirements and assist in building up a sound economy.

In response to this most recent Congressional request, a study of the forest situation in the United States was made and the current research program prepared. The present position and relation of research in the organization of the U. S. Forest Service are diagrammed in Chart 2. It is recognized that such a full program cannot be financed, organized,

Above, badly denuded and eroded middle fork of Ford Canyon, Utah, a source of destructive flood waters.

Below, terracing and revegetation of such slopes as those shown above can prevent denudation and erosion.

and staffed in a single year. Five years is about as far ahead as it is safe to make specific plans.

Major Problems

Research has been organized not only on a regional basis, but on the basis of major problems, some of which are found in many of the natural forest regions and some of which are particularly acute in but one or a few regions. This has resulted in a high degree of organizational flexibility. The following typical examples of outstanding problems illustrate some of the highlights of this program.

Timber

Understocking on forest lands is the most general and critical forest problem. For the country as a whole, forest lands have less than half the stock of growing timber that they should have. Actual growth is far short of potential growth. In the South—one of the most highly productive regions of the United States—the average annual yield is less than 200 board feet per acre (2.2 $m^3(r)$ per hectare).[1] Yet on the Crossett Experimental Forest in Arkansas, for example, the yield has been stepped up to 500 board feet per acre (5.6 $m^3(r)$ per ha.) and a yield of 700 board feet per acre (7.8 $m^3(r)$ per ha.) seems likely. At the same time, the stand has been more than doubled in volume and remarkably improved in quality. The forest lands of the United States could just as well be growing two trees where now there is only one.

Diminishing supplies of virgin timber in the Pacific Northwest and the replacement of the virgin forests by second growth present new and entirely different problems of regeneration, protection, management, and utilization. The future of the lumber industry in this region may well rest upon the early solution of the problem of conversion from a virgin to a second-growth timber economy.

Cut-over and burned-over lands in the Lake States should be growing valuable timber trees instead of worthless brush. The main problems include the development of methods of successful planting and tending of the growing stands, and effective fire protection.

Low-grade and little-used species on millions of acres of woodlands in the East must be utilized or otherwise removed before real forest management can be practiced. In order to make a start toward re-establishment and management of high-grade forests in this region, profitable outlets must be found for this huge quantity of low-grade material. This presents one of the country's major problems of wood utilization.

Wood waste is another nation-wide utilization problem. For the country as a whole, a third of each tree cut is now left in the woods. An additional third is lost in processing. These appalling wastes can be reduced through devising and applying improved harvesting and transportation methods and new and improved mechanical and chemical conversion processes.

Water

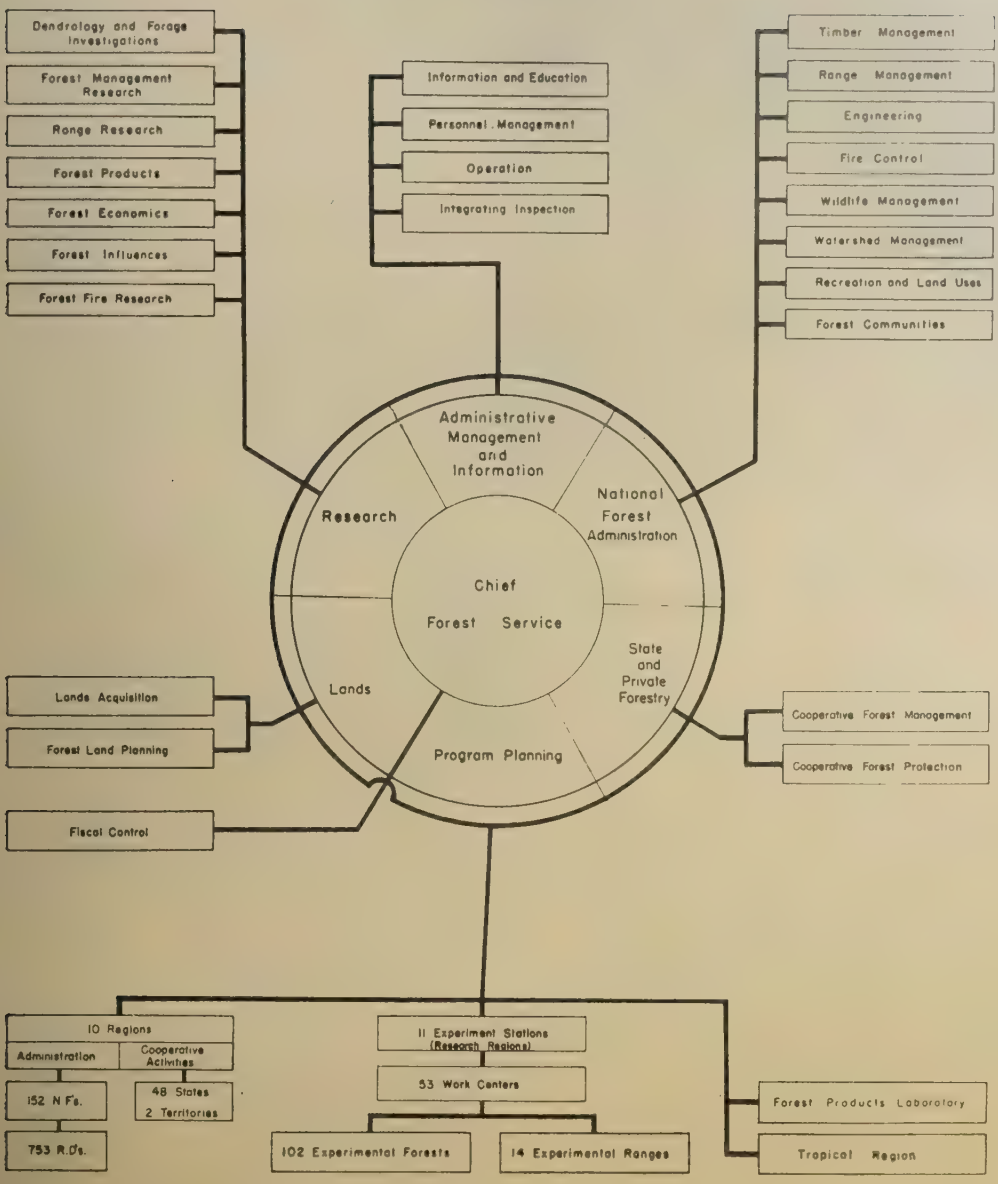
Decreasing supplies of water for industrial and domestic use are important and critical problems the country over. Location and expansion of many industries are dependent on water. Much of the civilization of the West is threatened by decreasing supplies of water for irrigation. At the same time, damages from floods and sedimentation are increasing. These problems are directly related to the treatment of watershed forests. Research must furnish the basis for upstream flood-control programs.

[1] In this article volumes of wood are expressed in cubic meters, as follows: $m^3(r)$ = cubic meters of roundwood; $m^3(s)$ = cubic meters of sawn timber.

CHART 2

ORGANIZATION CHART

FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE



Oct. 15, 1947

Range

Inadequate forage production on several hundred million acres of depleted range lands presents critical restoration problems of vital importance to the permanent welfare of the West. Such lands are subject to severe erosion and damaging floods. The once good grass of earlier days is largely gone. Frequently, 100 acres (40.5 ha.) are required to support one cow through a grazing season. Grazing capacity of these lands can be stepped up from five to ten times through development of improved management and more economical reseeding methods.

Annual production on a well-stocked experimental farm woodlot in the Crossett Experimental Forest, U. S. A., includes 12,000 board feet (54 m^3 (r)) of sawlogs, 17 cords (43 m^3 (r)) of pulpwood, and 33 fence posts. The whole is worth $320 at the mill.

Fire

Fires on forest and range lands every year destroy valuable timber and forage and reduce the timber-producing, forage-producing, and water-holding capacity of the land, although much progress in controlling such fires has been made in the last 40 years. The problem of control and prevention of fire is a major element in most of the other problems mentioned above.

The general objective of the proposed research program is to discover and develop solutions to all of these problems.

Co-operation and Co-ordination

It is obviously a direct public responsibility to provide a factual basis for more effective management of the millions of acres of public lands. About one-fourth of the forest lands, nearly two-fifths of the timber of the United States, and about a third of the range lands, are now under Federal ownership. This was in fact the orientation of earlier research programs at the regional stations, but it shortly became evident that the Federal Government cannot disregard the national interests in the use of the essentially similar private forest and range lands. Well-managed forests and ranges provide employment, public income, self-supporting communities, watershed protection, inexpensive recreation, and other benefits. This is of particular significance in rural areas.

Some 3,200,000 farmers own forest land and there are some one million owners of commercial nonfarm forest land. Three-fourths of private forests are in ownership of less than 5,000 acres (2,000 ha.). More than 20,000 medium-sized and large establishments manufacture forest products, and even larger numbers of smaller enterprises engage in sawing lumber and in harvesting and processing other forest products. Because of this diversified character of forest ownership and industry, improvements in forest practice, as in other agricultural operations, must depend largely upon institutionalized research. Public research is the most economical, practical, and effective means of providing the information needed for management of such private lands.

Research on public forests and ranges can readily be supplemented and adapted to meet the problems of private ownership. Local research and application of results on a comprehensive, balanced basis for all parts of the country can be accomplished most effectively through co-operation with State and private agencies. The Forest Service has formal co-operative research agreements with practically every State and Federal agency interested in forestry and with many private agencies and individuals. Through such joint action between the Forest Service and other forestry groups, research can be co-ordinated and efforts concentrated in such a way as to meet the most vital forest problems effectively.

This adaptation of Forest Service research to the needs of various classes of forest owners and forest products users and processors, and the co-ordination of Forest Service research with that of other agencies, is furthered by the device of forest research advisory councils or boards. These boards usually consist of representatives of interested public and private agencies, such as State forest services, agricultural colleges and extension services, forestry schools, consulting foresters, forest owners, forest industries, and industries consuming forest products. They advise and assist in the formulation of research programs of the regional forest and range experiment stations.

Further co-ordination of forestry research with the administration and management of the public forests is assured by the close contact maintained between the research and the national-forest administration branches of the Forest Service. An annual research program conference for each regional station further ensures attention to administrative needs. This rela-

Forest Products Laboratory of the U. S. Forest Service, at Madison, Wisconsin, where utilization research in the United States is centered.

tionship helps to orient the research program toward the needs of the forest administrators and managers, and also tends to induce the early application of research findings to the national forest lands.

Because of the general interlocking interests that exist in the management and utilization of timber, range, and water resources, a co-ordinated research program obviously is necessary. Forests and range serve multiple purposes. If forestry is to be successful—if millions of acres of land are to be most profitably employed for timber and forage crops—if wood, a basic resource, is to be provided in abundance for use in countless products—then the plans must recognize the essential unity of biological and economic problems of timber, range, and water management and utilization.

The forest is a complex biological unit, in which soil, water, microscopic and macroscopic flora and fauna, microclimate, and trees all interact, so that change or disturbance of one affects all of the others. Likewise, wood is a complex material, with closely interrelated but exceedingly variable physical, chemical, structural, mechanical, and working properties, all of which are influenced by the silvicultural conditions under which the trees grow.

These are the reasons for the modern concept of co-ordinated or group attack on major forestry research problems by specialists in several fields. For example, plant physiologists, soil scientists, entomologists, and pathologists in other bureaus of the Department of Agriculture and in universities and other agencies commonly co-operate closely with the silvicultural specialists at the forest experiment stations.

Testing the strength of a glued laminated wood arch at the U. S. Forest Products Laboratory.

Organization and Program

Shortly after control over the national forests was assigned to the Forest Service, their administration, which had been centralized at Washington, was decentralized by shifting it largely (except for over-all control and policy formulation) to local regional offices, closer to the forests and to the people who use them. Originally there were six of these regions. Now there are eleven, including Alaska and Puerto Rico.

The organization of forest service research has followed much the same pattern. For some years after the national forest regional offices were established, research work was directly under their control. Later, the experiment stations were made independent of the regional offices, but they have continued to maintain close contact with them. Although they are subject to over-all control from Washington, they have a large degree of responsibility for planning and carrying out research programs.

Now the research is conducted within the framework of regional forest and range experiment stations and a forest products laboratory. Twelve such regional experiment stations are now in operation: Allegheny, Appalachian, California, Central States, Intermountain, Lake States, Northern Rocky Mountain, Pacific Northwest, Rocky Mountain, Southern, Southwestern, and the Tropical with headquarters in Puerto Rico. The program provides for two additional regional stations, one in Alaska and the other in the Great Plains, making a total of fourteen.

The relationship of these stations to the major forest associations of the nation are shown in the following analysis. The large number of such associations is indicative of the reasons for regionalization of forest research work.

Regional Analysis of Forest Species

Region	Key Forest Associations	Number of Species of Considerable Commercial Importance
Northeastern	Spruce—fir (*Picea—Abies*)	2
	White pine (*Pinus strobus*)	2
	Birch—beech—maple—hemlock (*Betula—Fagus—Acer—Tsuga*)	4
	Chestnut—chestnut oak—yellow poplar (*Castanea—Quercus—Liriodendron*)	11
	Oak—pine (*Quercus—Pinus*)	5
Southeastern	Oak—pine	14
	Longleaf—loblolly—slash pines (*Pinus palustris—P. echinata—P. caribaea*)	4
	Chestnut—chestnut oak—yellow poplar	19
Lake States	Spruce—fir	4
	Jack—red—white pines (*Pinus banksiana—P. resinosa—P. strobus*)	3
	Birch—beech—maple—hemlock	5
Central States	Oak—hickory (*Quercus—Carya*)	25
Southern States	Longleaf—loblolly—slash pines	4
	Oak—pine	11
	Cypress—tupelo—sweetgum (*Taxodium—Nyssa—Liquidambar*)	19
Northern Rocky Mountain	Western white pine (*Pinus monticola*)	3
	Ponderosa pine (*Pinus ponderosa*)	2
	Spruce—fir	4
	Lodgepole pine (*Pinus contorta*	1

CHART 3

JULY 1, 1942

FOREST SERVICE RESEARCH CENTERS AND FIELD STATIONS

ALLEGHENY
1 EASTERN SHORE
2 BELTSVILLE RES. CENTER
3 STANDING STONE
4 KANE
5 LEBANON
6 CHERAW0
7 FINCH-PRUTH
8 HOPKINS MEMORIAL
9 DALE RIVER
10 BARTLETT
11 MASSABESIC

APPALACHIAN
13 BLACKLANDS
14 HOFFMAN FOREST
15 SANTEE
16 TOCCOA
17 COWEETA
18 BENT CREEK
19 FERNOW
20 LEE
21 ALABAMA

CALIFORNIA
25 DEVIL CANYON
26 SAN DIMAS
27 KINGS RIVER
28 SAN JOAQUIN
29 STANISLAUS
30 INST OF FOR GENETICS
31 FEATHER RIVER
32 BLACK'S MOUNTAIN
33 SHASTA
34 MODOC
35 SWAIN MOUNTAIN
36 YUROK

CENTRAL STATES
40 PORTSMOUTH
41 SOUTHERN ILLINOIS
42 SYLAMORE
43 HACKER CREEK

INTERMOUNTAIN
47 GREAT BASIN
48 DESERT
49 RUBY
50 SANTA ROSA
51 ARROWROCK
52 BOISE BASIN
53 DUBOIS
54 LOGAN
55 WASATCH

LAKE STATES
60 DENSMORE DUNES
61 CHIPPEWA
62 SUPERIOR
63 UPPER PENINSULA
64 RHINELEY
65 LOWER STORMOUR
66 UPPER MISSISSIPPI

NORTHERN ROCKY MOUNTAIN
70 DECEPTION CREEK
71 PRIEST RIVER
72 CORAM
73 BERNICE
74 MILES CITY
75 VIGILANTE

PACIFIC NORTHWEST
80 WIND RIVER
81 BLUE MOUNTAIN
82 PRINGLE FALLS
83 PORT ORFORD CEDAR
84 CASCADE HEAD
85 STARKEY

ROCKY MOUNTAIN
90 FRASER
91 CENTRAL PLAINS
92 MANITOU PARK
93 FREMONT

SOUTHERN
95 SAN JACINTO
96 PALUSTRIS
97 IRONS FORK
98 CROSSETT
99 DELTA
100 CHEWALLA
101 HARRISON
102 MITCHITI
103 OLUSTEE

SOUTHWESTERN
105 SANTA RITA
106 LONG VALLEY
107 FORT VALLEY
108 SIERRA ANCHA
109 MT GRAHAM
110 CLOUDCROFT
111 JORNADA

TROPICAL
115 RIO ABAJO
116 EL VERDE

Region	Key Forest Associations	Number of Species of Considerable Commercial Importance
Rocky Mountain	Spruce—fir	4
	Lodgepole pine	1
	Ponderosa pine	1
	Aspen (*Populus*)	1
Intermountain	Ponderosa pine	1
	Spruce—fir	4
	Piñon—juniper (*Pinus—Juniperus*)	3
	Aspen	1
Southwestern	Ponderosa pine	2
	Piñon—juniper	4
Pacific Northwest	Pacific Douglas fir (*Pseudotsuga*)	5
	Ponderosa pine	3
California	Ponderosa—sugar pines (*Pinus ponderosa—P. lambertiana*)	7
	Redwood (*Sequoia*)	1
Alaska	Spruce—fir	4
	Birch—poplar—spruce (*Betula—Populus—Picea*)	3

The Forest Products Laboratory is at Madison, Wisconsin. The major part of research in forest, range, and watershed management is conducted in the woods and on the ranges. Experience has demonstrated that widely scattered experimental plots, even on national forests or other public lands, cannot be satisfactorily administered, protected, or utilized for intensive and long-time research. Therefore, in order to provide suitable field laboratories, there have been set aside from existing national forests and other Federal lands, permanent areas for such experimentation in each experiment station region. The schematic organization of regional stations and experimental forests is shown in Chart 3.

Timber, Water, and Range Research

As this research program is developed, the territory of the existing regional stations is zoned into a series of areas of perhaps 10 million acres (4 million ha.), each constituting distinctive conditions with respect to forest or other vegetation types, soils, and general land and water management problems. These areas are designed as nearly as possible to fit natural geographic and economic lines. Some 56 such research areas have been established to date. The plan calls for about 30 more. Within each of these are located one or more experimental units representative of important conditions. Upon these experimental forests or ranges, intensive experiments in timber, forage, and water production and management are conducted and new and better methods tested and demonstrated on a scale representative of the small holdings characteristic of most forest and range ownership.

These experimental units provide a place where farm foresters, engineers, extension specialists, forest and range land owners, and all others concerned can come and see good forest, range, and water management and get accurate and specific information on how it is done. Some of these experimental forests and ranges are already functioning and producing valuable results. The program calls for the further development of these and additional units in a planned and orderly fashion.

At some convenient headquarters point, normally at or near one of the experimental forests or ranges, are located a small group of skilled research men with the necessary assistants. These men not only operat the experimental areas but also conduct research else where within the zone tributary to the work center, if it is necessary to meet its research needs. The experimental forests and ranges are thus a distinctive and essential feature of the program, but research effort is by no means restricted to their boundaries. As used here the term experimental forest, watershed, or range includes not only work done on the specific forest, watershed, or range but supplemental research done elsewhere in the general zone. This plan makes it possible to meet the needs of local practice and yet work collectively toward the solution of regional and national problems.

Wood Utilization Research

The research program on utilization includes studies at the Forest Products Laboratory. In this field there is a three-fold opportunity to meet pressing economic needs: (1) the opportunity to use more of the material not now utilized—4,000 million cubic feet (110 million $m^3(r)$) of wood and mill waste and 1,500 million cubic feet (42 million $m^3(r)$) of timber killed by destructive agencies out of our 13,000 million cubic feet (370 million $m^3(r)$) total annual timber drain, and defective trees that are left in the woods; (2) the opportunity to convert to useful goods, at a profit, those trees from the forest stand when good management dictates their removal; (3) the opportunity to obtain for the consumer better performance of commodities made from wood, at a lower cost. To these ends the program of wood utilization research includes: improved and extended chemical utilization; the utilization of low-grade and little-used woods; the application to peacetime use of natural and modified wood products developed for war purposes; and continued improvements in such broad fields as structural performance, seasoning, preserving, painting, gluing, and pulping. Pilot plants are operated to overcome the serious time lag that all too frequently occurs between the discovery of a new product or process by forest products research and its industrial application. The program also includes forest utilization units at the forest experiment stations to provide greater benefits from utilization research to timber growers, forest products processors, and consumers.

Resource Surveys

Fundamental to the development of programs for better forest management and utilization is an adequate knowledge of forest resources. Data on standing timber supply, rates of timber growth and drain, and wood requirements are provided by a national survey of forest resources, set up by a specific appropriation in 1930. In a country as large as the United States, a detailed survey of all forests, property by property or unit by unit of management, obviously would be impractical at the present stage of development and would fail to meet the need for speed in obtaining comparable knowledge for each natural forest region and for the entire country. Consequently, the survey has been based mainly on sampling methods, similar to the strip surveys employed in the Scandinavian countries. Within the last few years, advantage has been taken of the great advances that have been made in aerial surveying technique. Since only about half of the United States has been covered by the forest survey to date, provision is made in this

plan for accelerated efforts to complete the survey as rapidly as possible and to bring information up to date on areas already covered. This will provide basic economic data useful to both public agencies and to private forest owners and industries.

Other economic studies of forest resources are designed to determine better means of organizing and financing forest properties, justifiable public and private expenditures on forest and range lands commensurate with returns, more effective methods of marketing forest products, and possibilities of expanded and permanent forest employment. Such investigations are of direct aid in determining measures and policies whereby maximum returns may be obtained from different uses of the forests.

Summary

The principal features of the organization of research in the U. S. Forest Service are:

1. a forest and range experiment station in each of the natural forest regions, set up to attack the problems of forest, range, and watershed of that region;
2. widespread co-operative relations with other agencies and institutions in each region, designed to provide the most fully integrated and expert attack;
3. systematic consultation with administrative users of research to discuss needs and programs and to make research results rapidly and fully available;
4. a problem analysis, both regional and national, periodically brought up to date;
5. a system of research centers in each region through which application of methods to local conditions can be worked out, in addition to serving as centers for primary research and as demonstration areas;
6. a central Forest Products Laboratory, with regional wood utilization units, which deal with special regional aspects;
7. planning and direction of a nation-wide forest survey, including development and application of inventory and sampling methods; and
8. central office co-ordination of programs and maintenance of technical standards, but with a high degree of regional autonomy in selection and development of research projects.

Photographs and charts for this article were provided by courtesy of the U. S. Forest Service.

Forestry as a Career in the United States

By HENRY CLEPPER

ACCORDING to C. H. Guise of Cornell University, who annually compiles statistics on enrollment of students in schools of forestry in the United States of America for the Society of American Foresters, the number of students in 29 professional schools for the academic year 1947/1948 was 7,873. This is an all-time high figure, 30 percent more than the previous peak year of 1937/1938.

That some levelling off in enrollment may be expected is indicated by the registration of freshmen—2,061 this year as against 3,611 last year. An increase in total enrollment during the next two or three years is unlikely unless additional colleges and universities, not now offering professional courses in forestry, should decide to do so. In this connection it is significant that the Council of the Society of American Foresters at its meeting in Minneapolis on 18 December 1947 recommended that new schools or departments for professional training in forestry should not be established.

The outlook for professional training is somewhat complicated, however, by the new schools of professional caliber that have come into existence since the recent war. Although Professor Guise's statistics on enrollment are based on 29 schools, actually there are now 35 institutions offering training claimed to be of professional status. Most of these new schools have not had graduates as yet, and probably will not have any for another two years.

Twenty-two institutions are now listed as having approved schools, that is, they are accredited for professional forestry by the Council of the Society of American Foresters.

Employment Prospects

Employment prospects in forestry in the United States during the next two or three years cannot be forecast with accuracy. The Society of American Foresters has no definite figures, other than those which indicate trends. Hence, although no claim is made for the exactness of the following estimates, they may be of interest in permitting a rough comparison between prospective supply and demand.

As nearly as I can estimate, there are now in the United States about 11,000 foresters employed in forestry and in closely allied fields. It should be noted that this figure represents the number of foresters actually employed in forestry after 48 years of professional forestry education in the United States.

Now, as nearly as I can estimate employment possibilities, the approximate number of graduates who may be expected to find technical work in forestry during the next two or three years is 1,000, classified as follows:

Federal government (all agencies)	250
State and municipal government (including highway, game, and park departments)	300
Private and industrial	350
Miscellaneous (including teaching)	100

The conclusion to be drawn from the foregoing figures is that during the next few years our professional schools will graduate more foresters than needed. This situation exists in nearly all professions. It may not be serious for forestry, provided (1) school enrollment levels off according to demand, and (2) no more new schools are started.

Forest Conditions in Syria and Lebanon

By J. ROLLEY

STUDY of forest resources and potentialities in member countries is one of the basic tasks of the Food and Agriculture Organization. Attention is rightly due to conditions in Middle East countries, many of which were celebrated in olden times for their rich forests.

It would be going too far to say that nothing now remains of these ancient forests but certainly they are now few in number and scattered, and their ranks are constantly being thinned. It is to be feared that they will disappear entirely unless proper protective methods are quickly brought to bear.

Forest Area in Syria and Lebanon

It is difficult to provide figures for forest area in Syria and Lebanon which can give a proper indication of their forest resources, as for instance do figures for countries of Europe or North America. The description "forest" is interpreted very liberally in the Levant and embraces all areas carrying trees, whatever their species or the density of the stock. Again there is considerable uncertainty as to the exact extent of the forests, owing to the lack of detailed maps of a sufficiently large scale.

With these reservations, the forest area of Lebanon may be put at 7.4 percent or 74,000 hectares and of Syria at 1.4 percent or about 190,000 hectares.*

Regions and Principal Tree Species

The forests are almost without exception confined to the mountain ranges which stretch in a practically uninterrupted chain from the borders of Turkey to Palestine, parallel to the Mediterranean Sea.

Working down from north to south, the first forest range is Kurd-Dagh. This small tract situated to the northwest of Aleppo, near the railroad from Aleppo to Ankara, is practically denuded as the result of unrestrained cutting carried out during World War I. It is reduced to coppice of Kermes oak, *Quercus coccifera*, with occasional Aleppo pines, *Pinus halepensis*, laricio pine, *Pinus nigra var pallasiana*.

Covering a total area of about 25,000 hectares, the two forests of Baer and Bassit, situated to the northeast of Latakia and near the frontier of the Sandjak of Alexandretta, form the principal forest block in the whole of Syria and Lebanon. The Bassit, close to the sea, is covered with fairly dense and almost pure stands by Aleppo pine, unfortunately ravaged by fire. The Baer, situated at a higher altitude (800 m.), comprises Aleppo pine and both Chevelu oak, *Quercus cerris*, and Vallones oak, *Q. ægilops*. Young growth is often entirely made up of these two deciduous oaks. The forest is for the most part spared from the axe but, around the edges, wood is removed for use in tobacco-drying plants.

Djebel Ansarieh, the range running parallel to the coast, rises to 1,500 meters and stretches for 100 kilometers down to the Homs gap. The crests are covered with fine uniform stands of deciduous oaks of commercial value. There are several isolated pockets of Cedar of Lebanon, *Cedrus libani*, Cilician fir, *Abies cilicica*, and juniper, *Juniperus excelsa*. Evergreen oaks occur in pure stands where the elevation drops to about 800 meters. The forests of Djebel Ansarieh cover a total area of about 20,000 hectares.

To the north of the mountain massif of Lebanon, which reaches a height of 3,000 meters, two very interesting forest areas occur on the foothills overlooking the plain of Tell Kalah between elevations of 400 and 1,400 meters. These are the Akkar and the Dennieh.

In the Akkar, as the altitude increases, one finds first mixed crops of Aleppo pine and Kermes oak, then stands of deciduous oaks, then about 1,200 meters of almost pure coniferous stands of Cilician fir, and lastly open woods of juniper, as the tree line is approached at 1,800 meters.

The forest of Djebel Amoua, which forms a part of the Akkar, deserves special mention. Formed of well-grown pure stands of Cilician fir, reproducing themselves quite satisfactorily and practically intact be-

*Since this article was written, FAO has received a reply to its Forest Inventory Questionnaire for Syria, in which the figures differ to some degree from those quoted above.

cause of inaccessibility, this forest contains a lot of timber more than 2 meters in diameter and 80 meters in height. The forest stands of Akkar cover about 8,000 hectares.

The Dennieh leads off from the Akkar towards the west. It comprises some good mixed stands of fir and cedar and occasional plots of pure cedar. Unfortunately, the cedars are often misshapen and forked.

The forests of Hermel and Baalbeck stretch along the east flank of the Lebanon mountains beyond the Akkar. They cover about 28,000 hectares in Lebanon proper and 5,000 hectares in trans-Lebanon. The growing stock consists of devastated stands of evergreen oaks of poor density, overcut, and with many gaps. They are bound to disappear.

To the east of Tripoli, on the crests of the Lebanon range, one may mention the shrinking cedar forests of the high valley of the Kadischa. Amongst the most interesting is the forest of Ehden. It is near the sources of the Kadischa, close to the picturesque village of Becharre, where is found the celebrated grove of cedars known throughout the Christian world. This park, located in a barren valley at 1,600 meters, now consists of about ten trees, but nearly all measure more than 3 meters in diameter. Some have attained 12 meters in circumference.

Farther to the south, the valley of the Nahr Ibrahim (the Adonis River of the ancients) holds a tract of almost pure Aleppo pine and near the watershed a vigorous crop of juniper which ends at an elevation of 2,000 meters.

The hill country near Beyrouth is fairly well wooded. The forests are made up of piñon pine. *Pinus pinea.* They were artificially planted in 1860. Under private ownership, they are well tended because of the products they yield (edible seed, timber, and fuelwood).

Clearing in the forest of fir, Abies cilicica, *in the Djebel Amoua range, Akkar, North Lebanon.*

On the Djebel Barouk, which prolongs the Lebanon range to the col of the Beidar, are several outlying forest tracts. There is the cedar forest of Barouk, in poor condition. Stands of Kermes oak are fairly extensive at medium altitudes near Djezzine and on the east slopes of the mountain, at Amik, Andjar, and Rachaya, a town situated at the foot of the Hermont. They are for the most part destroyed and, though they cover a considerable area, have little value.

At the frontier between Lebanon and Palestine, tracts of Kermes oak cover more than 6,000 hectares on the Lebanon side and stretch over into Palestine. These stands are in a piteous state because they serve as grazing grounds for enormous herds of goats. This use ruins the forest but will be continued, as the country's economy is founded on goats. In fact, the goat droppings are assiduously harvested and transported by sea to Beyrouth and Tripoli where they are used as fertilizer in the orange and banana plantations along the coast.

The inland mountain ranges are practically entirely deforested. Except for the date palm, the pistachio-nut tree is the only tree species of the desert. This tree, remarkable for its habitat, forms open stands containing only a few trees per hectare, but extending over enormous areas in two places in the Syrian desert (Djebel Abd-el-Aaziz in Djezireh and Djebel Bilas in the Palmyre region).

To complete this brief listing of the principal forest regions of Syria and Lebanon, an estimate of the areas covered by the most important species is given in the following paragraphs.

Oaks cover perhaps 50 percent of the total forested area of the two countries, about 132,000 hectares. The Kermes oak alone covers more than four-fifths of this area and the rest consists of deciduous oaks, *Quercus ægilops, Quercus cerris,* and *Quercus libani.*

The conifers come second. They cover about 65,000 hectares. The chief species in order of importance are: Aleppo pine, piñon pine, laricio pine, Cilician fir, juniper, cedar, and cyprus, *Cupressus sempervirens.*

Secondary species cover 12 percent of the forested area, about 30,000 hectares; included here are wild fruit, walnut, maple, poplar, arbutus, and pistachio trees.

Lastly about 35,000 hectares are covered by semi-forest type trees, which are all included under the term "forest." These are principally willows, cultivated fruits, figs, laurels, almonds, and olives.

Forest Ownership

The legal standing as regards timber and forests is fairly straightforward. In Syria in accordance with ancient Turkish rights, all forested land belonged to the Sultan. After the dissolution of the Ottoman Empire, ownership devolved on the State or *Mubah.* In Lebanon, the same happened except for timber located in the old autonomous province of Lebanon which comprised forests of piñon pine in private ownership or *Mulk.* Certain state forests, called *Baltalika,* are encumbered with rights of usage in favor of riverside communities. This is particularly the case with tracts situated on the Lebanon-Palestine frontier.

Communal forests, public properties, and religious properties (*Wakfs*) are rare. The forested land of the two countries is made up of approximately 72 percent state forests, 23 percent privately owned for-

est, and only 5 percent of communal, public, and religious forests.

The legal position of some forest land is very confused as the result of innumerable ownership cases contested as much by communities as by individual persons and on which there have never been any rulings. It should be noted that the state forests are neither delimited nor marked and no precise boundary maps exist.

Main Forestry Problems

Forest Output

The forests of Syria and Lebanon, generally lacking in large trees as they are, are far from being capable of covering the timber requirements of these two countries. Moreover, they are not even managed to this end nor is cutting regulated, without which measures a proper supply cannot be secured even where the potentialities are recognized. Like most of the countries of the Mediterranean littoral, Syria and Lebanon are for the most part dependent on exports from Europe. Before World War II, imports came principally from Rumania, Scandinavia, Yugoslavia, and France. They consisted principally of softwood lumber (averaging 30,000 tons per year), hardwoods, principally beech (3,000 tons), and exotic woods (3,000 tons). A certain amount of fuelwood (2,500 tons) and charcoal (1,000 tons) was also imported, as well as an important tonnage of paper pulp.

The demand still exists, but as recent FAO statements have indicated, Europe can scarcely hope to export its timber while its own enormous demands remain unsatisfied. The Middle East therefore runs the risk of suffering from an unprecedented shortage of timber. This situation endangers the existence of the forests which these countries still possess, because naturally there will be a temptation to exploit the remaining resources so as to cope with essential requirements. At all costs, it is necessary to avert these dangers which must surely ruin the forest forever.

Range Lands

The forest too often provides the only means of pasturage for livestock. As in all Mediterranean countries, it is the goat which dominates the livestock picture. Lebanon has more than 500,000 head of goats. In Syria, however, sheep are the more widespread since there are immense ranges of pasturage.

Grazing is practically nonexistent even in the hill country, where the temperate climate and the relatively abundant rainfall are favorable to the formation of mountain pasturage. The forest therefore is at all seasons subjected to grazing and browsing, particularly by goats. The enormous number of these animals, amounting to more than a million head for the two countries, gives some idea of the damage caused to the forest and particularly to its regeneration and young stock, which provide good sustenance. The number of livestock supported by each hectare of forest is very considerable. In Lebanon, for example, on forest stands covering 50,000 hectares, the stock averages about ten head of goats per hectare, a very high figure and obviously about ten times too great.

The proper protection of most of the young forest stock is evidently greatly desirable, but in practice it is beyond the realm of achievement. In fact, in the present agricultural economy of the Middle East countries, it would meet with hostility from a very important part of the population and, to be made effective, would require an enormous staff of personnel and guards.

Cedars of Lebanon, lower right, near Becharre, northwest slope of the Lebanon Range.

To remedy this situation, it seems necessary first to strive to create range lands outside the forest by putting to use the tracts of high and medium hill country obviously best suited to pasturage. Thereafter, one should be able by appropriate measures to get a diminution in the goat herds.

Reforestation

Once the protection of existing forests is assured, the reforestation of areas suited for tree growing should be undertaken without delay, since this would give promise of a control of erosion, improvement in water resources, perhaps even a slight modification of climatic conditions, and lastly the chance of satisfying the greater part of the timber and fuel requirements of the two countries. The possible tourist attractions resulting from this work should not be lost sight of, especially in Lebanon, where the hotel industry is experiencing a great boom owing to the attraction of the coolness of the mountains in summer and the possibilities of winter sports.

No reforestation of any consequence has yet been undertaken in Syria and Lebanon, although in Palestine and Cyprus far-reaching work has already been accomplished. Experience is therefore lacking. However, several general principles can be stated. The climate will militate against the success of any reforestation schemes. Rainfall is satisfactory only from October to March, and the long summer period is entirely dry. The growth of plants will therefore be slow. In addition, the deterioration of the denuded soil is such as to require the initial use of accommodating and resistant species. Lastly, the whole work can have no chance of success unless the interest of the indigenous populations can be aroused to the benefits that they will derive from such work, and consequently to the need for them to protect the young plantations, principally against the incursions of livestock.

Open stands of Juniperus excelsa *dotted over northeastern slope of Lebanon Range. Average elevation, 1,800 m.*

For the reforestation of bare soil the intermediate species found most useful is *Acacia cyanophylla,* a very hardy species which has yielded good results in the island of Cyprus. However, it is short-lived and it should only be planted at low altitudes. The robinia, *Robinia pseudoacacia,* can replace it at greater elevations. For the main species, one should first mention the piñon pine, which was introduced into Lebanon at least a century ago and has now established itself well on a variety of soil types. Reforestation can be obtained from broadcast sowing after plowing or light breaking of the ground. The Aleppo pine can be similarly used but its products do not greatly interest the local planter. These two species should not be used above 1,000 meters. At greater elevations, it seems better to make use of indigenous species, such as cedar, Cilician fir, and juniper. At the same time, control experiments should be carried out for the introduction of exotic species.

The zones to be reforested must be defined. It seems that their extent is not likely to be so great as might appear. In fact, efforts should be limited principally to the mountainous sectors subject to erosion, to regions where existing growth needs strengthening or restocking, and to areas which are tourist centers.

Conclusion

This brief survey of the forest situation in Syria and Lebanon makes clear the necessity for undertaking a thorough study of the basic forest problems in the Middle East. This vast work, which should be sponsored by FAO and should cover all the countries of the Middle East, in particular Arabia, should be the first step towards the restoration of forest cover in this part of the world.

It must be stressed that all possible programs of action to be undertaken must take fully into account the agricultural and pastoral situations of the countries concerned. The forest's fundamental role is to limit erosion and constitute a source of primary products essential to the economic life of a country. The agricultural economy almost completely conditions life in the Middle East, being the main source of livelihood of the majority of peoples of Asia Minor, Syria, the valleys of the Tigris and Euphrates, and the Arabian peninsula.

Today no practical forestry program could be undertaken with any hope of success unless it received the approval of the farmer and the shepherd, whether they were sedentary, as in Lebanon, or nomadic or seminomadic, as in Syria and Arabia.

A similar problem exists in all the countries bordering the Mediterranean. The 1946 FAO Mission to Greece was able to define the general lines for forestry action, based on the protection of existing wooded resources and their extension through a progressive program of reforestation. It recommended control of rights to pasturage in the forest, properly adapted to the economic circumstances of the country and capable of receiving the agreement of the populations concerned.

There is no doubt that only a precise study of the particular forestry problems of the Middle East will enable putting forward complete recommendations whose application would make possible the reconstitution and enlargement of the forest heritage of the countries concerned.

Photographs for this article were furnished by J. Rolley and by the Military Service of Lebanon.

Forestry Activities in Europe

Report from the Director-General to the Second Session of the Council of FAO

IT GIVES me great pleasure to report that the work on European timber and forestry problems carried out at Geneva by FAO begins to yield tangible results. The European timber situation shows definite signs of improvement, and two agreements concluded recently by the European Timber Committee justify hopes for further increases in timber production and exports during 1948, a stabilization of timber prices, and a satisfactory distribution of available supplies. These were, as Council members recall, the principal objectives sought by the recommendations of the International Timber Conference organized in May 1947 at Marianske Lazne by the Czechoslovak Government and FAO.

In accordance with the conclusions of that conference and subsequent instructions by FAO's annual Conference, an FAO task force was established last September at the Palais des Nations in Geneva to organize and service a European Timber Committee, established within the framework of the Economic Commission for Europe, and to act as European outpost of FAO's Division of Forestry and Forest Products. For the first six months this small staff unit was headed by Dr. Egon Glesinger, Chief of the Forest Products Branch, who has now returned to Washington and is succeeded in Geneva by Mr. Roy D. Cameron, former Dominion Forester of Canada, who recently joined the staff of the Division of Forestry and Forest Products as chief of its European branch.

Increased Timber Supplies in 1947

The Timber Committee has held two sessions. The first session, which was presided over by Mr. Gunnar Lange of Sweden and at which Mr. Marcel Leloup, Director of the Division of Forestry and Forest Products, represented the Director General, was able to register the fact that all major wood-producing countries of Europe (with the exception of the U.S.S.R.) were already carrying out the Marianske Lazne recommendation to increase the output and exports of timber by 10 percent. As a result, the timber-importing nations of Europe and the Mediterranean area were able to receive 2.7 million standards of softwood during 1947, which constitutes an increase of roughly one million standards over 1946.

Timber Agreements for 1948 and 1949

The second session of the Timber Committee was held from 26 to 31 January and elected Mr. Bernard Dufay (France), who is also Vice-Chairman of FAO's Standing Advisory Committee for Forestry and Forest Products, as permanent Chairman for 1948 and Mr. B. Ropelewski (Poland) as Vice-Chairman. The opening meeting was addressed by Mr. F. L. McDougall, Counselor of FAO, on behalf of the Director General. In the course of that session, two formal agreements were concluded.

(1) *Agreement for Increased Timber Production*

Europe's major timber-exporting countries have undertaken to increase softwood exports by 550,000 standards in 1948 and 720,000 standards in 1949, provided they can secure, by 1 July 1948, assurances of receiving woodworking equipment, additional supplies of coal and coke, and supplementary food allocations for forest workers as well as fodder for horses engaged in logging operations. This agreement is the result of six months' negotiations and screening organized by the secretariat of the Timber Committee.

The plan involves a credit request from Austria, Czechoslovakia, Finland, Poland, and Yugoslavia of 16 million dollars for the purchase of the earlier mentioned timber production facilities. If this is granted in time, these countries have agreed to export additional timber and pitprops worth 42.4 million dollars in 1948 and 68.8 million dollars in 1949. The International Bank for Reconstruction and Development has followed closely these negotiations, sent an observer to the meetings of the Timber Subcommittee, and has now taken the matter under active consideration.

Sweden has not requested a credit but has undertaken to increase exports in 1948 by 100,000 standards of softwood and 300,000 m^3 of pitprops against an additional allocation of one million tons of coke. Immediately after the Timber Subcommittee's session, this request was taken up by ECE's Coal Committee and arrangements have been made to provide Sweden with practically all the additional coke her representatives at the Coal Committee considered necessary. In this way, Sweden's undertaking for additional exports in 1948 is about to take effect.

(2) *Agreement on Buying Limits for 1948*

This second agreement was reached by all European importing countries with the concurrence of the representatives of all exporting countries present at the meeting. It limits import purchases for 1948 to specific figures set out in the report for each country and amounting to a total of 2.7 million standards, i.e., approximately the present effective demand

(see below). These figures are binding until 1 July 1948 but are regarded only as a first installment. It is expected that a second installment will be released for 1948 as soon as more is known about purchasing facilities resulting from ERP (European Recovery Plan).

Currency Difficulties and Effective Demand

In appraising these two agreements, a further fact should be taken into consideration. The Timber Committee already found in October that currency difficulties were preventing many nations from buying timber they needed. In January, the Committee concluded that these monetary difficulties have reduced Europe's effective import demand for timber to 2.6 million standards compared to estimated essential needs for the same year of 4.3 million standards. Prospective export supplies are placed at 2.4 million standards and are thus even below the present effective demand.

Substantially larger imports than those listed as effective demand are indispensable to prevent lack of timber becoming a serious bottleneck in current reconstruction plans. Most delegates expect that purchasing facilities to be obtained in connection with ERP are likely to raise effective timber import demand in 1948 to somewhere between 3.5 and 4 million standards. In that case the European timber shortage would again become very acute.

The two agreements listed above were considered necessary and urgent to take care of this development. Their combined effect should be to stabilize timber prices at their present level, possibly even to produce a slight reduction and at the same time to make sure that all European importing nations can get their share of available export supplies.

Pitprops

The Timber Subcommittee has also concerned itself with the pitprops situation. While there appears to be a small deficit on paper, it is believed that export supplies of pitprops in 1948 would be sufficient to cover the requirements of European coal production even if plans for expansion of coal output were fully accomplished, which is not considered likely.

Quarterly Timber Bulletin

FAO's Geneva Office for Forestry and Forest Products has also started to issue a quarterly commodity report on timber containing, in addition to factual information, regular statistics on production, stocks, trade, and prices. This bulletin is published jointly by FAO and ECE.

Other joint projects with ECE undertaken by the Geneva forestry office include a timber consumption study and extension of secretarial and statistical services to forest products of key importance not yet adequately covered by present activities, such as pitprops, railway ties, fiber boards, and plywood.

Co-operation with IRO

Recently FAO's European forestry staff was invited by Mr. Tuck, Executive Secretary of the International Refugee Organization, to undertake a joint project designed to provide displaced persons with prefabricated houses before sending them to their new home countries ("Operation Snail").

FAO Projects

In addition to these joint projects with other international organizations, the Geneva staff is engaged in an increasing number of purely FAO activities. Foremost among these is the organization of FAO's Forestry and Forest Products Commission for Europe, which is to hold its first session during June in Geneva and to attempt a co-ordination of forestry legislation and management among all European countries in pursuance of recommendations made by the Marianske Lazne Conference and endorsed by FAO's annual Conference of 1947 (see Commission II report, paragraph No. 49). Mr. Dufay (France) has been designated as Chairman of the Commission. In this way, FAO's European Forestry and Forest Products Commission will function with the same chairman and the same secretariat as the European Timber Committee.

Co-operation with European governments and National FAO Committees, contacts with FAO's Rome office, organization of technical meetings, and assumption of secretariat functions for the International Poplar Commission and a number of other specialzed European bodies constitute some of the other activities now performed by the Geneva Forestry Office. The preparation of the World Forestry Congress to be held in Finland in the summer of 1949 will become another major assignment of the Geneva staff.

Conclusions

I believe that the activities which I have been able to report to the Council are encouraging. In the course of a personal visit which Mr. McDougall and I paid to Geneva in January, we were particularly impressed by the fact that this new type of co-operation, initiated with regional outposts of the United Nations and specialized agencies, provides FAO with the possibility of getting right down to practical operations. It might be worthwhile to examine, in the light of this first experience, the desirability of extending such regional co-operation with UN bodies to other fields of FAO's activities and even to other continents.

Issues for the Council's Consideration

The report on the activities of the Timber Committee to the forthcoming third plenary session of ECE is attached to this note for the consideration of the Council of FAO. In the light of this report and of the preceding comments, the Council may wish to deal with the following issues:

(1) Review of the agreement for increased timber production reached by the Timber Committee in general and of its implications with regard to special allocations of food and fodder.

(2) Review of the results achieved by the European Timber Committee with a view to making suggestions regarding its future activities and status.

(3) Consideration of the work and program of the Forestry and Forest Products Branch at Geneva.

(4) Action with regard to establishment of FAO's Forestry and Forest Products Commission for Europe.

European Timber Subcommittee

Statement by Prof. G. Myrdal, Executive Secretary of the Economic Commission for Europe

The European Working Group of FAO's Division of Forestry and Forest Products has been entrusted with providing the secretariat for ECE's Timber Subcommittee. After organizing this secretariat and establishing working relations with ECE, Dr. Egon Glesinger has recently returned to Washington from Geneva. The work is now being carried on by Mr. D. Roy Cameron, Chief of the Division's European Working Group. On the occasion of this transfer of activities, the Executive Secretary of ECE, Mr. Gunnar Myrdal, released the press communique from which the following passages are quoted.

"The Timber Subcommittee has become an effective, new institution in European economic life. This newly developed arrangement for dealing with European timber problems through international co-operative action owes much of its success to the effective collaboration of the ECE and FAO. No small share of credit for this success is due to the Food and Agriculture Organization, whose efforts wedded to those of the Economic Commission for Europe, made it possible to reach international agreements on European timber production and trade at the Subcommittee's recent second session.

"It is the first time in the history of the United Nations, that a United Nations organ and a Specialized Agency have pooled their resources in so intimate a way and on such a large scale. Among the advantages accruing from this co-operative working arrangement are the achievement of a unified international policy and a considerable saving in costs. Both of these advantages are appreciated by the Governments and the taxpayers."

The Subcommittee is to a certain extent an outgrowth of the FAO Timber Conference held at Marianske Lazne, Czechoslovakia, last April and May. A great deal of progress has been made since that time, when little was known about the real timber situation in Europe. At that time last spring, the ECE was getting under way in the field of timber, and Mr. Myrdal, Executive Secretary of ECE, and Sir John Boyd Orr, Director General of FAO, arranged for the co-operative efforts of these organizations on the timber problems. A working arrangement was established under which FAO provided the technical officers, and they in turn directed the substantive work on timber within the ECE. The ECE provided secretarial assistance, various facilities, and conference services.

The liaison between the ECE and FAO on timber problems is being organized on a continuing basis. For the purpose, FAO has established a European Forestry Office at the headquarters of the ECE.

The experiment in collaboration has worked so well that the same type of co-operation is expected to develop in other fields of joint interest between the ECE and specialized agencies.

First Session of the European Forestry and Forest Products Commission

Readers of *Unasylva* will be well aware that FAO's European Forestry and Forest Products Office has, in accordance with recommendations of the Marianske Lazne Timber Conference, collaborated closely with the Economic Commission for Europe, in organizing the FAO ECE Timber Subcommittee in agreement with the general trend of action suggested by the Conference for finding a short-term solution to the European timber shortage.

This co operation has already borne fruit, but timber and forestry problems go beyond the scope of ECE interests. Measures to alleviate the immediate European timber shortage are naturally its concern, but one must not lose sight of the fact that the shortage is basically due to insufficient production from the forests of the continent. The effects of this will be felt more and more, as the domestic timber requirements of other continents increase or as their diminished resources oblige them to curtail exports to Europe.

Problems of timber and forestry should not be regarded only from the short-term view. Rather, it is impossible to say precisely where the short term ends and the long term begins, since measures taken to settle urgent problems must inevitably have repercussions for the future, perhaps the far distant future.

This is why the Marianske Lazne Conference also recommended that European countries interested in forest matters "should meet together from time to time to exchange information and views about their problems in the field of medium and long-term forestry." This recommendation, endorsed by the annual Conference of FAO held at Geneva, brought into being the European Forestry and Forest Products Commission. Composed of experts fully qualified to speak for and represent their governments, this Commission will assemble in June to examine such problems.

There is an obvious need to prevent overlapping of the activities of the FAO-ECE Timber Subcommittee and the Forestry and Forest Products Commission. This is assured by the fact that the chairmanship of both bodies has been vested in Mr. B. Dufay, Director General of Waters and Forests, France, while the secretariat for both is to be provided by FAO's European Forestry and Forest Products Office at Geneva.

In making initial contacts at the first meeting of the Commission, delegates will find themselves confronted with a wide field for action. Without prejudging the issue, one may say that discussions will be directed on the one hand, towards means of increasing the productivity of European forests as quickly as possible; and on the other hand, towards securing, equally rapidly, the complete and rational utilization of the output promised by technical developments.

These two types of problems must bring a large number of others in their train. The Marianske Lazne Conference was content to draw attention to the more important and especially recommended study of periodic inventories, development of forestry and forest products research, problems of manpower and improved working conditions both in the forest and factory, plans for the use of barren land, international control of insect pests and disease, and seed and plant certification for reforestation projects.

Such a wide variety of questions cannot of course be treated and solved at a single meeting of the European Commission. All European countries with forest traditions have their own programs and definite forest policies. The Commission offers these countries a good opportunity of comparing and discussing these programs and policies, with the aim of their co-ordination into a European program, so as to attain the maximum value from them. The discussions of the FAO-ECE Timber Subcommittee indicate this to be a task of some urgency. The co-operation of European countries at the first session of the Forestry and Forest Products Commission will mark the first step towards its accomplishment.

News Of The World

The items appearing here are condensed selections of news thought to be of interest to readers of UNASYLVA. *The Editor will be glad to receive direct from readers authenticated items of interest and of news value for this part of the review.*

Forestry

General Forestry

EIRE

The forestry program envisages the planting of 10,000 acres (4,000 hectares) annually towards a goal of 600,000 acres (240,000 hectares) of commercial timber. It is estimated that 30 million tree plants will be needed. As such a quantity is not available in the country, the question of their provision is under consideration. The government will pay a subsidy per acre to those who undertake planting. Technical advice will be available, and it is planned to provide equipment and to create an organization for this purpose. The Forestry Division intends to grow in its State nurseries all the plants necessary for State forest lands.

ETHIOPIA

According to recent data the country's total surface is 380,000 square miles (984,000 km^2). The area covered by thickly growing forests is estimated at 10,000 square miles (26,000 km^2). Distribution of ownership is very complicated and title is usually very difficult to determine. The forests can be divided roughly into three principal types: (1) the moist climatic forest with three main subdivisions (a) tropical mountain rain forests with a variety of tree species and with three stories; (b) the tropical high mountain and conifer forests containing softwoods, particularly *Juniperus procera* and hardwoods; and (c) bamboo, *Arundinaria alpina*, mountain forests of very little economic importance; (2) the dry climatic forests divided into (a) the tropical wooded savannah with sparse and small trees, and (b) the tropical brushwood growths covering a very large area; (3) the moist soil forests along rivers and water courses. The most promising species are *Juniperus procera* and *Podocarpus* spp.

TURKEY

Since 1941 and 1942 the Forest Service has been reorganized into a special department with 88 administrative units, each directed by an inspector and divided into 5-8 cantonments. A number of forest stations have been established and a number of forest ranger schools are being started. The forests contain a large proportion of softwoods, especially in the central plateau and in the inland region near the Black Sea. As in the Mediterranean countries the greatest problems are goats and, especially in the south, the habit of setting fire to the brush to clear land for agricultural use. Numerous reforestation projects are being initiated. For this purpose, the country has been divided into eight regions, each with a central plant nursery. In central Anatolia, the region where the problem is most urgent, there are four nurseries. Seven of these nurseries are already supplying plants. By law, each village can be obliged to reforest a certain surface which is to serve as communal forest. Interesting and large-scale use has been made of *Eucalyptus rostrata* for afforestation of marsh lands, particularly around Tarsus.

Testing Timber

BRITISH EMPIRE

Many timbers available for export from the British Empire have a higher reputation for durability in their countries of origin than other woods which are well known on overseas markets. In some cases, timbers which have been exported for many years have established such a reputation that buyers are not persuaded easily to accept alternative timbers less well known but probably of similar or even better durability. Such is the case with Australian jarrah, *Eucalyptus marginata*, while other eucalypt hardwoods are not readily accepted abroad because of unfamiliarity of buyers with their properties. It has been suggested, therefore, that an inter-Empire durability test might be laid down in order to obtain a comparative picture of the durability of less well known timbers. Such a test must be considered desirable, as a reputation established in the country of origin is not sufficient to convince overseas buyers and is actually no guarantee that performance will be satisfactory. In other countries, the biological hazard may be very different. The best index of durability is satisfactory performance under varying conditions of decay and termite hazard. A listing would be available of 30-50 Empire timbers, including well known timbers such as jarrah, *Eucalyptus marginata;* teak, *Tectona grandis;* and iroko, *Chlorophora excelsa*, to serve as bases of comparison. A suitable specimen size would be pieces approximately 2x2x24 in. (5x5x60 cm.) and testing sites should be selected in at least six different countries. Where possible, sites should represent a combined decay and termite hazard. Each timber species to be tested should be represented by a suitable number of trees and the specimens divided into matched sets for testing.

Silviculture and Management

CANADA

An ever recurring question is that of the supply of Christmas trees. In 1946, 1.6 million Christmas trees were sent to the United States from the Province of Quebec. Grave concern has been expressed about these inroads into the forest. It should be kept in mind, however, that harm is done only when cutting is unplanned and unchecked. Otherwise, if Christmas trees are cut as part of clearing operations or if the tops of felled trees are used for this purpose, it is not only harmless but even beneficial to the forest and is a source of revenue which is very valuable when setting up management plans.

UNITED STATES OF AMERICA

The first Sustained Yield Unit in a federal forest has been officially established in the Carson National Forest in New Mexico. This is the first application of the Sustained Yield Unit Act of 29 March 1944 and comprises public forests covering an area of 73,600 acres (29,800 hectares) of which 27,000 acres (10,900 hectares) are virgin forest. For the first thirty years, fellings will apply exclusively to the virgin forests to allow for 38,000 acres (15,400 hectares) of forest which were cut over 35 years ago to have matured sufficiently to supply future output. The main species is *Pinus ponderosa* and the estimated annual crop is of 1.5 million board feet (6,800 m^3(s)). Organization of the unit to ensure best pos-

sible utilization of the crop will include the moving of a sawmill to a more favorable location and the building of a packing-case factory. This would increase employment in this area by about 400 percent and would ensure constant employment to the population of the surrounding towns and communities.

Experiments in tree seeding by helicopter are being continued in Oregon and have now even progressed to the extent of commercialization. The pilot controls even distribution of seeds by an ingenious acoustic method. It is reported that 2,600 acres (1,100 hectares) in a number of plots have been seeded in this manner.

Experimentation by the Brewton branch of the Southern Forest Experimentation Station in Alabama has shown that the best and cheapest method of freeing the ground of scrub oak, *Quercus macrocarpa*, to make way for more valuable species, is the use of sulphamate of ammonium. The crystals are deposited in a slash made with an axe at the base of the tree. The leaves begin to fall 5 days later and the amount of young shoots is negligible.

Mensuration, Increment, and Yield

UNITED STATES OF AMERICA

The Forest Service of South Carolina has been experimenting with helicopters for forest surveying. The usual method is to use aeroplanes for taking photographs on which the forest areas are classed according to type of stand and type of density. The sample plots to be surveyed on the ground are then determined with the help of these photographs. Helicopters have been used to distinguish between the different types of forest. Observations were taken at low altitude at regularly spaced points along flight lines at regular intervals. It was thus possible to check the correctness of the data supplied by these observations. The data proved to be 85 percent correct This is a very encouraging result as compared with the correctness of data obtained from direct interpretation from photographs taken from aeroplanes and the cost is not much higher. Furthermore, a number of future uses for the helicopter have become apparent, such as direct evaluation of volume, and low altitude photogrammetry.

Forest Protection

AUSTRALIA

Plans have been considered to make boys the spearhead of a "Save the Forests" campaign by establishing permanent camps where schoolboys will be trained in forestry and become forest conscious. The reason for marshaling all possible forces for fire fighting is obvious when one considers that in Victoria, for instance, bush fires in one year destroyed 2,000 million board feet (9 million m^3 (r) of mountain ash of saw-milling quality. It is feared that another such fire would wipe out for nearly a century the great forests of this utility timber, as mountain ash seed will not live through flame. Each experimental camp consists of dormitories, mess hut and kitchen, recreation room, showers, offices, and stores.

CANADA

Recognizing the serious threat to the national economy in the destruction of Canadian forests by insect pests and the shortage of trained investigators in this field, a Canada-wide system of eight annual awards, to be known as Forest Industries Entomological Scholarships, has been sponsored by the Dominion's four leading forest industrial associations. The scholarships will be available for forestry students registered in the second year, or beyond, at universities, the awards to continue for a period of four years. They are offered through the Forest Insects Control Board.

GERMANY

Artificially regenerated stands of *Picea* in Western Germany are being seriously endangered by infestation with *Bostrychidae*. The propagation of these insects has been favored by dry periods of spring and early summer which have occurred since 1943. The quantity of dead standing timber is estimated at 4 million m^3 (r) in Thuringia, 4 million m^3 (r) in Baden, and 1 million m^3 (r) in Wurtemburg. Infestation has spread to Silesia and Austria.

UNITED STATES OF AMERICA

In some of the Southern States, expenditure for protection against forest fires, which is federally subsidized in part, does not cover all forest lands. In 11 of these States something like 100 million acres (40 million hectares) of forest land were protected, apart from government-owned forests. Nevertheless, in those 11 States 73 million acres (30 million hectares) of forest land were unprotected and it was on those lands that, in 1947, 93 per cent of forest fires were counted.

Among the new projects to be tested for fire-fighting equipment is a newly developed rocket projector or mortar for the purpose of throwing fire-extinguishing material several hundred yards. Also to be conducted is an over-all investigation of the use of water, wetting agents, and other chemical additives to water. Among the projects in progress are the use of the helicopter in fire control, spray nozzle studies, tests of military and commercial type vehicles, development of tractor tankers with trailers for them and of slip-on pumper tanker units, and the use of power flame throwers. Studies to date indicate that helicopters in present production need an increase in hovering ceiling, increase in useful load, and improvement in the stability of the craft to reduce pilot fatigue.

An industrial concern has now undertaken the development of a power flame thrower to meet fire-fighting needs. Experiments are to be carried out at the three fire-control equipment centers located in Portland, Oregon; Arcadia, California; and Roscommon, Michigan.

Bombs may now be used as effective weapons against forest fires. They are triggered by proximity fuses and charged with fire-fighting chemicals. The bombs can be dropped from aircraft and explode at tree-top level.

VENEZUELA

In view of the heavy damage caused by forest fires in 1947, the Ministry of Agriculture has started a far-flung propaganda campaign for fire fighting. The press, the cinema, schools, and private organizations have been asked to cooperate in this drive against forest fires.

Forest Products

Conversion

UNITED STATES OF AMERICA

Chemists at the Madison Forest Products Laboratory have developed a non-swelling wood by giving the wood a steam bath in a vapor composed of pyradine and an acid closely resembling that of vinegar. The vapor permeates the wood, swelling it permanently.

A new method of barking logs has been developed and is now in use in a plywood plant. The new equipment removes bark by compression and shearing action. It gives a clean separation which leaves the log free from bark, without cutting into the sapwood. One man operates the machine from a carriage which moves the bark-removing compression head across the log as it turns in a lathe. Controls mounted upon the carriage guide a rotating wheel which compresses and shears off the bark. An air cylinder and piston furnish the power for the compression head, which automatically follows the log's contours. The new barker makes practical application of the simple principle that less force is required to crush bark than to crush green wood.

A fire-resistant paint intended to stop small fires before they spread has been developed in a number of shades. It is claimed that exposure of a wall covered with this paint to the blue flame of a Bunsen burner for one minute merely forms brown blisters and that the flames die down within 8 15 seconds after the burner is removed.

A liquid plastic recently marketed is said to be the first phenolic resin coating material which can be cured without heat or pressure. It can be brushed or sprayed and is said to be waterproof, fireproof, solvent-proof and chemical-proof. It is not a plastic paint but rather a phenolic resin in liquid form.

Utilization

UNITED KINGDOM

The possibility of preserving the various kinds of wallboard against mold by means of impregnating them with chemicals is being investigated. Owing to the

lack of other building materials, the use of different kinds of wallboard is increasing considerably. The investigation is particularly important because wallboard cannot, in most cases, be kept in a dry state. It was found that chlorophenol is the most lasting preservative agent against decay and mold and even against insects. The most appropriate chemicals are pentachlorophenol and its sodium salt. These chemicals can be mixed with the raw material during the manufacturing process.

An interesting practical application of the use of stress grading was given recently in London in rebuilding a damaged house containing a wall that had previously been carried on a series of 6 in. x 9 in. 15 cm. x 23 cm.) beams. In order to save timber, a stress-graded beam was used with a consequent over-all saving of 33.3 percent. The beams used were 4 in. x 9 in. (10 cm. x 23 cm.) Douglas fir, stress-graded to a bending stress of 1,200 lb./sq. in. (85 kg./cm^2).

Timber used in the construction of three emergency bridges placed across the Thames in wartime is to be removed and used in housing. It is hoped to recover 2,000 tons of weatherbeaten timber, mostly best quality Douglas fir or pine imported from Canada in 1939.

United States of America

Research has developed new and interesting uses for dust from the redwood, *Sequoia sempervirens*, bark. This dust, a waste product from the making of insulating material, is being used as a fungicide in wine making and in the petroleum industry to replace tannin, which oil field drillers have in the past relied upon to lower the viscosity of oil mud. It has to be treated chemically to thin it to the point where it can be brought to the surface easily, yet viscous enough so that it will carry to the surface the cutting made by the drill. By sampling the cuttings, the driller knows when he has reached oil-bearing sands. Now that tannin is in short supply, oil men have been keenly interested in finding a substitute. Redwood bark dust is made to yield a product which has been named *sodium palconate* and which performs all the functions of tannic acid compounds and more. Tests are said to show that it is superior to any other oil mud thinner. It is also believed that the new material will be used as a water softener and as a filtering agent for removing metallic salts from water. Furthermore, the new redwood by-product appears to have certain applications in the oil flotation process required in the reduction of certain ores.

With the steadily increasing and particularly advantageous practice of handling lumber in unit packages comes loading and shipping stock in unit bundles on flat cars. Apart from the considerable saving in handling time, there are other advantages to this method of loading and unloading lumber. As each unit is tallied individually and identified, it remains intact until the unit band is cut. Thus, the tally does not change and the lumber does not have to be counted over again. In this connection, the banding of lumber also tends to reduce pilfering. Thieves hesitate to steal lumber left in the yard or at a job when it is bound and sealed. Units are now made up containing 4,000 board feet (1,200 m^3 (s)) of finished lumber. These are bound at each end with steel strapping 1¼ in. (3 cm.) wide.

Economics and Statistics

Algeria

Efforts are being made to widen the circle of buyers of Algerian cork. The U.S.S.R. is being given first consideration, since the attempts to introduce cork oaks on the shores of the Black Sea did not succeed. In exchange, the U.S.S.R. might deliver asbestos, which is used in large quantities by Algerian industries.

Brazil

A new paper mill has been producing newsprint at the rate of about 60 metric tons daily and sulphite pulp at a daily rate of about 40 metric tons. The newsprint output represents half of the anticipated output of the mill and one-third of the country's newsprint consumption, as indicated by import figures.

Chile

The International Bank for Reconstruction and Development has sent a mission to make economic and technical-studies in view of the country's application for a $40,000,000 loan to be used in financing hydroelectric development, forest industries, railway electrification, transportation facilities, and port mechanization.

Norway

The government program for the timber-felling season 1947/48 shows the highest figure ever before recorded: as much as 8 million m^3 (r) of wood are to be felled. In order to achieve this end, working methods will be improved, chiefly by employing mechanical saws and by using more efficient means of transportation.

Poland

Poland is said to wish to export various kinds of furniture to Great Britain in the next year. Most of the orders received concern bedroom and kitchen furniture. A sample lot of furniture is to be sent to the United States.

Surinam

A postwar boom of unprecedented size has brought 40 to 50 times higher sales of timber in the last two years than in any previous years. This was caused, it is said, by urgent demands in the Netherlands for all kinds of timber for reconstruction and by increased interest in the United States in Surinam timber for manufacturing veneer and plywood. For these purposes, baboon wood, which could not be sold profitably before the war, seems to meet all the requirements. Baboon trees grow on ground which is swampy most of the year, thereby precluding the use of tractors. Thus far, trees have been cut only along waterways and floated down.

United States of America

A postwar increase in papermaking capacity of 3,250,000 tons annually in the United States is reported. The figures follow:

	Tons
Capacity (31 Dec. 1945)	20,282,050
Increases in:	
Paper	1,372,060
Paperboard	1,410,950
Building board	475,850
Total Increases, 1946-48	3,258,860
Capacity (31 Dec. 1948)	23,540,910

Manufacturers of paper, lumber, furniture, and plywood, and others using wood or wood by-products as raw materials should be combined into one organization for mutual benefit. This would allow for exchange of information on costs and other problems, and would especially be of advantage in small industrial units.

Policy, Legislation, and Administration

Argentina

The *Dirección Forestal* (Forestry Department) has now become independent of the *Dirección General de Tierras y Bosques* (Department of Lands and Forests). It is now directly responsible to the Ministry of Agriculture.

Burma

It is officially announced that the timber industry is to be nationalized on 1 June 1948. Two Burmese and five British companies will be affected.

Finland

Private forest owners have organized an association in order to put their technical and economic forest interests and activities on a co-operative footing. The association is to be a very large one and will only start after it has achieved a membership of 15,000 and the necessary amount of capital.

Kenya

A national park is to be established with an area of 7,000 sq. mi. (18,000 km^2). The Tsavo National Park will thus become one of the greatest game sanctuaries in the world.

Softwoods are being grown by the government Forest Service and there seems to be an exceptional opportunity for easing the world scarcity of timber. The effort is badly hampered by lack of scientific experts and the government is anxious to recruit from the universities and from the European personnel of the Indian and Burmese Forest Services.

United Kingdom

A Forestry Section was established in the British Federated Home Timber Associations in July 1947. Membership is now 55. It is its intention to act in close co-operation with the land owners, the Forestry Commission, and other interested parties and to agree on a policy which shall include the dissemination of information on all matters concerning the interests and welfare of those engaged in forestry operations. Another aim is to establish friendly business relations with the nursery trade organizations and to arrange a plan for the bulk buying of plants.

UNITED STATES OF AMERICA

There are more than 230,000 farmers in Alabama, nearly all of whom have small wooded lots. All of these together, in addition to some small private forests, add up to 30 million acres (12 million hectares), or 69 percent of the total wooded surface of the State. It is believed that at present the output of these forests does not exceed 10 percent of their potential productive capacity. A campaign under the slogan "More Trees for Alabama" has been launched by the State Forestry Committee, which comprises representatives of all local, state, and federal services concerned with the forest lands, of the forest industries, of farmers, and of business men. The Committee has 73 trained foresters at its disposal.

In 1936, a program was initiated to encourage rational tapping for resin production in the farm forests of the Southern States. By 1948, 85 percent of those concerned were sharing in the application of this program. They undertook to follow the regulations laid down for fire protection and logging and received special subsidies for each tree tapped and worked during the year. These subsidies are much higher if tapping is carried out on a selective basis, and additional subsidies are paid to those who experiment with chemicals to stimulate production of resin.

Use of the recreational facilities provided by the forests is not only an interesting trend but also provides a source of revenue for the Forest Service. Generally speaking, recreational use of the forests is free but there are lodges, resorts, and hotels, as well as sport aids such as ski lifts, operated by private individuals as commercial undertakings and on which the government levies a permit fee. There are 4,537 approved recreation areas in the forests in 41 States. They include camp groups, picnic areas, and organization camps (for groups). There are 236 winter sports areas. Besides these formalized playgrounds, there are wilderness tracts and primitive areas which attract an astonishing number of persons. These visitors are described as hunters, fishermen, horsemen, hikers, and persons interested in nature study, photography, or some other hobby. The Forest Service, however, also recorded a great number of visitors who seemed to enjoy the woods even where there were no particular recreational facilities.

Meetings and Conventions

A Franco-British Colonial Conference was held in Paris in February 1948. An agreement was reached to open the African territories of the two countries to private and foreign investment and to accelerate development of Africa's resources along international rather than imperial lines.

Sponsored by the Forest Farmers Association of the United States, the Southern Forestry Conference was held in Jackson, Mississippi, on 18 and 19 February 1948. The theme of the Conference was "Trees for Market."

The French Association for the Advancement of Science met in Biarritz from 18-23 September 1947. Notable importance was given to forest sciences.

The Forest Products Research Society held its Annual Meeting at the Furniture Mart, Chicago, U. S. A., from 20-24 March. Papers were centered around utilization of low-grade logs and integration of industries.

Personalities

Clyde S. Martin, Chief Forester for the Weyerhaeuser Timber Company, Tacoma, Washington, has been elected President of the Society of American Foresters for a two-year term (1948-49), succeeding Shirley W. Allen, Professor of Forestry at the University of Michigan. Mr. Martin served as Vice-President for the term 1946-47.

Letters to the Editor

Sir,

May I call your attention to a news item in the November-December issue of *Unasylva*, Vol. I, No. 3, page 47. Under the heading of Union of South Africa the Jonkershoek Forestry Research Station is referred to as being in the Transvaal. It is, however, in the Cape Province, near Stellenbosch, and about 30 miles from Capetown.

L. P. D. GERTENBACH

Sir,

Would you please indicate, in your next issue of *Unasylva*, that the photograph of the warden of a sanctuary on the Atlantic Coast of France (Vol. I, No. 3, page 7) has been supplied by courtesy of the *Société nationale d'Acclimatation*. The picture was taken by Ed. Dechambre.

JEAN E. GOBERT

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CONVERTING FACTORS

Converting factors shown in Tables 2 - 5 have been approved for the use of FAO by two international conferences on forest statistics, held in Washington and Rome in 1947.

These factors are averages, adopted by agreement. However, if any country considers that serious errors in the conversion of its statistics will arise through use of these standardized factors, FAO will be prepared to use specific factors recommended by that country in converting its statistics.

A.—GENERAL MEASURES

Table 1.—STANDARD UNITS[1]

LENGTH	1 centimeter	= 0.3937 in.		1 inch	= 2.540 cm.
	1 meter	= 3.281 ft.		1 foot	= 0.3048 m.
	1 meter	= 1.094 yd.		1 yard	= 0.9144 m.
	1 kilometer	= 0.621 mile		1 mile	= 1.609 km.
	1 yard = 3 feet = 36 inches			**1 mile = 1,760 yards = 5,280 feet**	
AREA	1 cm^2	= 0.155 sq. in.		1 sq. in.	= 6.452 cm^2
	1 m^2	= 10.76 sq. ft.		1 sq. ft.	= 0.0929 m^2
	1 km^2	= 0.3861 sq. mi.		1 sq. mi.	= 2.59 km^2
	1 hectare	= 0.003861 sq. mi.		1 sq. mi.	= 259 ha.
	1 hectare	= 2.471 acres		1 acre	= 0.4047 ha.
	1 square kilometer = 100 hectares			**1 square mile = 640 acres**	
VOLUME	1 cm^3	= 0.061 cu. in.		1 cu. in.	= 16.39 cm^3
	1 m^3	= 35.31 cu. ft.		1 cu. ft.	= 0.02832 m^3
	1 liter	= 61 cu. in.		1 cu. in.	= 0.01639 liter
	1 liter	= 0.2642 gal. (U.S.)		1 gal. (U.S.)	= 3.785 liters
	1 liter	= 0.2200 gal. (Imp.)		1 gal. (Imp.)	= 4.546 liters
	1 liter = 1,000 cm^3			**1 gallon = 4 quarts**	
MASS	1 kilogram	= 2.205 pounds		1 pound	= 0.4536 kg.
	1 metric ton	= 1.102 short tons		1 short ton	= 0.9072 metric ton
	1 metric ton	= 0.9842 long tons		1 long ton	= 1.016 metric tons
PRESSURE	1 kg. per m^2	= 0.2048 lb. per sq. ft.		1 lb. per sq. ft.	= 4.882 kg. per m^2
	1 gm. per cm^2	= 0.0142 lb. per sq. in.		1 lb. per sq. in.	= 70.31 gm. per cm^2
DENSITY	1 kg. per m^3	= .06243 cu. ft.		1 lb. per cu. ft.	= 16.02 kg. per m^3
OTHER	1 m^2/ha.	= 4.356 sq. ft./acre		1 sq. ft./acre	= 0.2296 m^2/ha.
	1 m^3/ha.	= 14.29 cu. ft./acre		1 cu. ft./acre	= 0.07 m^3/ha.

[1]Inches, feet, yards, and miles are U.S.A.:British units.

B.—FOREST PRODUCTS MEASURES*

Table 2.—WEIGHTS

Product	Unit	Average Weight Shipped by Rail		Kilos per Cubic Meter	Pounds per Cubic Foot
		Kilos	Pounds[1]		
Sawlogs					
conifers	1,000 board feet	3,300	7,300	650	41
	Cubic meter	650	1,400		
broad-leaved	1,000 board feet	5,100	11,000	975	61
	Cubic meter	975	2,100		
Pulpwood	Cord	1,300	2,900	500	31
	Stere	350	770		
Fuelwood—mixed	Cord	1,800	4,000	700	44
	Stere	490	1,100		
Pitprops	Fathom	2,700	6,000	620	39
T & T Poles	1 piece—European	110	240	650	41
Sleepers					
conifers—Type A[2]	1 piece	62	140	620	39
conifers—Type B[2]	1 piece	52	110	620	39
broad-leaved—Type A[2]	1 piece	90	200	900	57
broad-leaved—Type B[2]	1 piece	75	170	900	57
Sawn lumber					
conifers	1,000 board feet	1,200	2,600	520	32
	Standard	2,400	5,300		
broad-leaved	1,000 board feet	1,700	3,700	730	46
	Standard	3,400	7,500		
Plywood					
Italian and French	Cubic meter	500	1,100	500	31
Austrian, Polish, and Czech	Cubic meter	650	1,400	650	41
Other	Cubic meter	650	1,400	650	41

[1]Calculated from the equivalent number of kilos. Since the figures are approximations and pounds per cubic foot are shown only to two figures, this result may not agree with the result obtained by multiplying pounds per cubic foot by the equivalent number of cubic feet.

[2]Type A sleepers average 10 pieces to the cubic meter; Type B, 12 pieces to the cubic meter.

*Conifers (softwoods) include all woods derived from trees which are classified botanically as gymnosperms. Broad-leaved (hardwoods) includes all woods classified botanically as angiosperms. The species belonging to this group are generally broad-leaved.

Table 3.—Roundwood

Product	Unit[1]	Solid Volume without Bark	
		Cubic Meters	Cubic Feet
Roundwood (general)	Cubic meter	1	35.3
	Cubic foot	0.0283	1
	Load	1.13	40.0
Sawlogs	1,000 board feet }	4.53	160
	1,000 super feet }		
	100 pulgadas	4.81	170
Pulpwood	Cord (128 cubic feet)	2.55	90.0
	Stere } conifers	0.75	26.5
	Raummeter }		
	Russian fathom	6.80	240
Fuelwood	Stere (conifers)	0.70	24.7
	Stere (broad-leaved)	0.65	23.0
	Cord (128 cubic feet)	2.12	75.0
	Russian fathom	5.66	200
Charcoal Wood	Metro linear	0.71	25
Pitprops	Fathom (216 cubic feet)	4.46	158
T & T Poles			
North America	1,000 linear feet	15.4	545.0
	1 piece	0.43	15.2
Europe	1 piece (conifers)	0.165	5.83

[1]Units are grouped opposite the products for which they are most commonly used, but certain units are applicable to a variety of products.

Table 4.—Processed Wood

Product	Unit	Solid Volume			Roundwood Equivalent	
		Cubic Meters	Cubic Feet	Standard	Cubic Meters	Cubic Feet
Sawn lumber and hewn wood	Standard	4.672	165	1	7.79	275
	1,000 board feet }	2.36	83.3	0.505	3.96	140
	1,000 super feet }					
	Load	1.42	50.0	0.303	2 36	83 3
	100 pulgadas	2.36	83.3	0.505	4.81	170
	Cubic meter	1	35 3	0.214	1.67	59.0
Sleepers	Load	1.42	50.0	0.303	2.58	91.1
	piece—Type A[1]	0.10	3.53	0.0214	0.182	6.43
	piece—Type B[1]	0.083	2.93	0.0178	0.142	5.00
Laths	1,000 pieces	0.195	6.9	0.042	.....	.....
Shingles	1 square	0.16	5.6	0.034	0.453	16.0
Plywood						
Thickness 5 mm.	1,000 square meters	5.00	177	.....	12.5	441
Thickness 10 mm. and over	Cubic meters	1	35.3	.....	2.5	88.3
Thickness ⅜ inch[2]	1,000 square feet	0.885	31.2	.....	1.11	39
Veneers, broad-leaved						
Average thickness 1/10 inch	1,000 square feet	0.235	8.3	.....	0.473	16.7

[1]Type A sleepers average 10 pieces to the cubic meter; Type B, 12 pieces to the cubic meter.

[2]Equivalents for ⅜" plywoods are based on production of softwood plywood from large logs on the west coast of North America.

Table 5.—Pulp and Paper

Product	Unit	Wood Pulp Content	Roundwood Equivalent	
			Cubic Meters	Cubic Feet
Wood pulp—				
Mechanical	Metric ton (air dry)		2.55	90
Chemical	Metric ton (air dry)		5.04	178
Newsprint paper	Metric ton	0.13 tons chemical pulp and 0.95 tons mechanical pulp	3.00	106
Paper other than newsprint	Metric ton	0 68 tons chemical pulp and 0.09 tons mechanical pulp	3.65	129
Building boards (fiber)	Metric ton	Average mechanical pulp about 0.62 tons	1.6	56
Paperboard other than building boards	Metric ton	0.32 tons chemical pulp and 0.07 tons mechanical pulp	1.8	63

THE Nations accepting this Constitution, being determined to promote the common welfare by furthering separate and collective action on their part for the purposes of

raising levels of nutrition and standards of living of the peoples under their respective jurisdictions,

securing improvements in the efficiency of the production and distribution of all food and agricultural products,

bettering the condition of rural populations,

and thus contributing toward an expanding world economy,

hereby establish the Food and Agriculture Organization of the United Nations . . . through which the Members will report to one another on the measures taken and the progress achieved in the fields of action set forth above.

—Preamble to the Constitution of the Food and Agriculture Organization of the United Nations

FAO Member Nations

Australia
Austria
Belgium
Bolivia
Brazil
Burma
Canada
Ceylon
Chile
China
Colombia
Costa Rica
Cuba
Czechoslovakia
Denmark
Dominican Republic
Ecuador
Egypt
Ethiopia
El Salvador
Finland
France
Greece
Guatemala
Haiti
Honduras
Hungary
Iceland
India
Iraq
Ireland
Italy
Lebanon
Liberia
Luxembourg
Mexico
Netherlands
New Zealand
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Norway
Pakistan
Panama
Paraguay
Peru
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